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THE

FOUNDRY TRADE JOURNAL

AND PATTERN-MAKER.

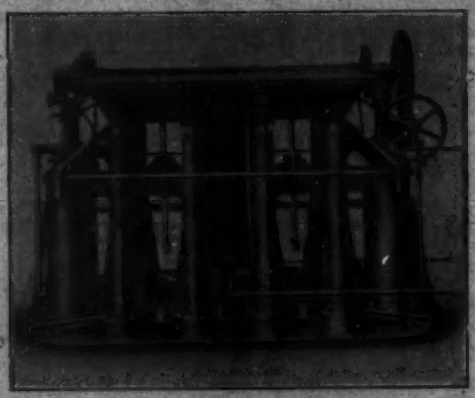
Vol. 21. No. 205. JANUARY 1919. Price SIXPENCE Net.

JOHN MACDONALD & SON, LTD.

ENGINEERS,

WATT STREET, MARYHILL, GLASGOW.

"AJAX"
TURNOVER
JARRING
MOULDING
MACHINE.



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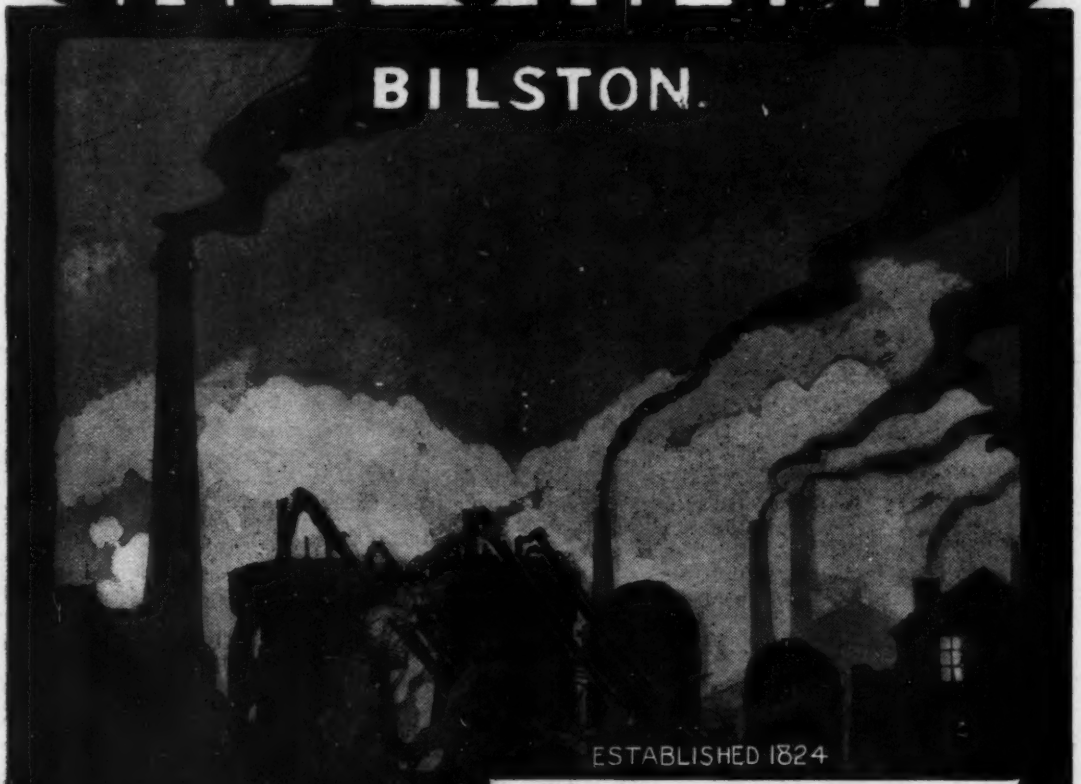

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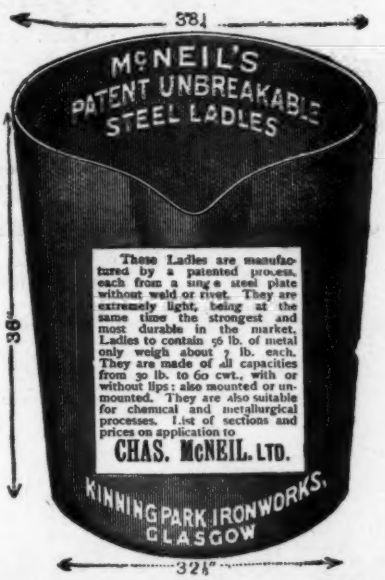
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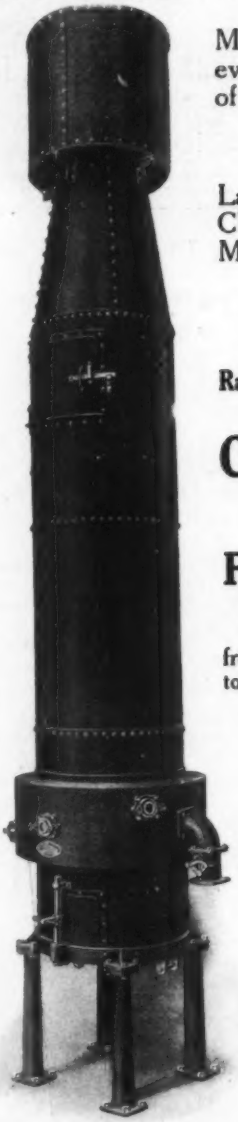

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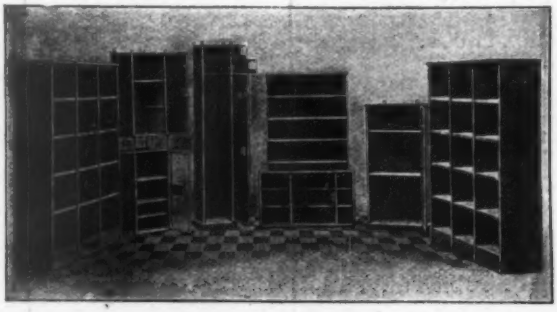

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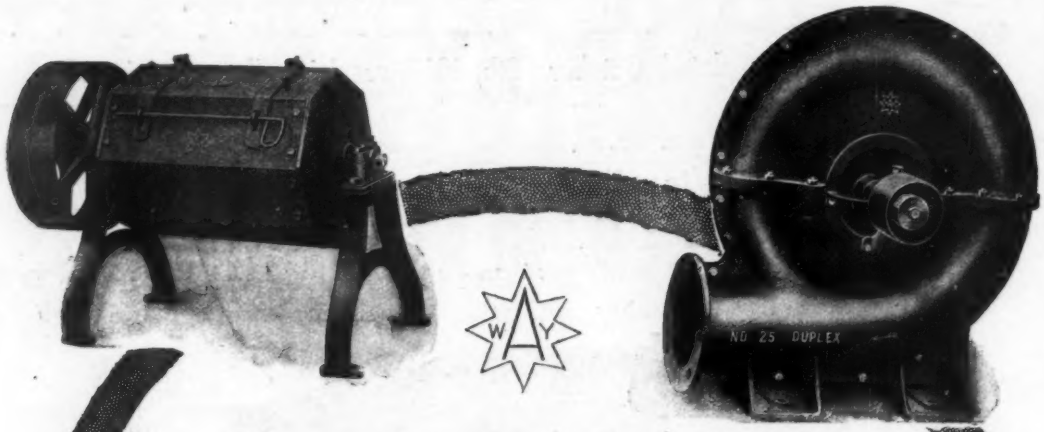

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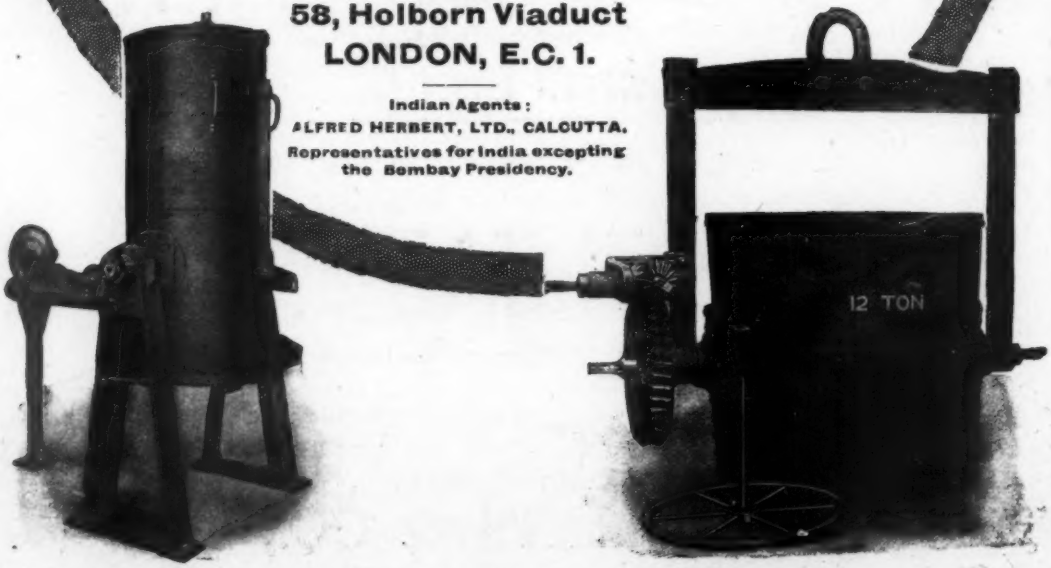

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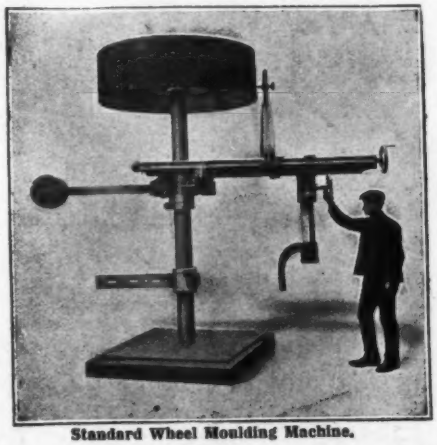

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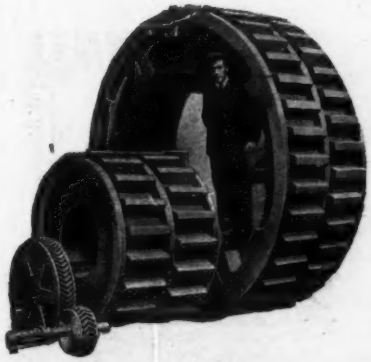

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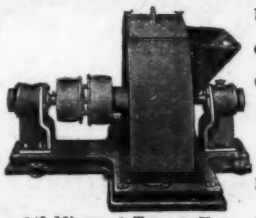

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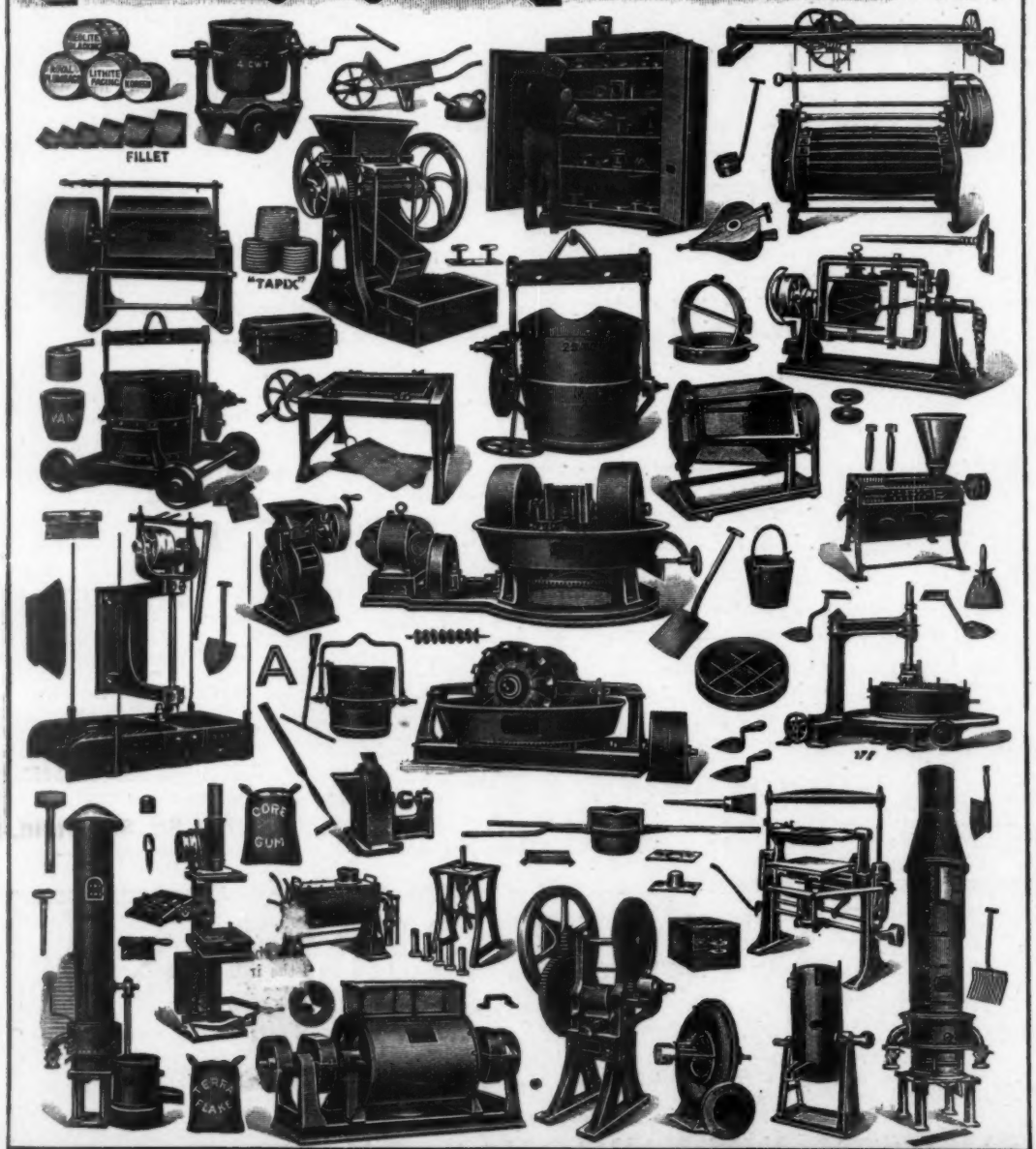

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AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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NOTES AND COMMENTS.

The Pig-Iron and Steel Output.

The following statistics of iron and steel output in Great Britain in 1917 were collected, as usual, by Mr. G. C. Lloyd, Supervisor of the Statistical Bureau, and issued with promptitude, but the Press Bureau refused permission at the time to publish the figures.

The output of steel ingots, excluding crucible steel, was 9,752,323 tons, as against 9,196,457 tons in 1916. In these figures are included 68,849 tons of electric steel ingots and castings, as against 49,256 tons in 1916. The output of steel ingots thus shows an increase of about 556,000 tons over the previous year. In spite of difficulties we managed to produce last year an ingot output about 2,000,000 tons in excess of the pre-war figure, a no small achievement. This increase in output has been almost exclusively confined to ingots made by the open-hearth process. The output of acid Bessemer ingots is some 30,000 tons lower than it was in 1916, and in view of the great demand for hematite pig, it is perhaps remarkable that sufficient pig-iron has been found to keep acid Bessemer converters working at such a high rate of production, because it need not be emphasised that a ton of pig-iron in the acid-Bessemer converter yields nowhere near the same return expressed in tons of ingots as when used in an open-hearth furnace. The output of basic-Bessemer ingots shows, on the other hand, an increase of 100,000 tons, and at 602,265 tons is the largest output reached since 1910. Taking, however, the production of Bessemer steel, both acid and basic, the 1917 figures are within 50,000 or 60,000 tons of the 1913 figures, so that the difference between the total steel output in 1913 of 7,663,000 tons and the 1917 output, viz., 2,100,000 tons, has been produced as to 2,000,000 tons by the open-hearth process.

As to the open-hearth process, the output (4,413,843 tons) of acid ingots in 1917 was an increase of 20,000 tons as compared with 1916, but the output of basic open-hearth ingots has grown by over 400,000 tons to 3,421,170 tons, which is easily a record, and is about 1,170,000 tons in excess of the pre-war figure.

So far as electric steel is concerned, the output shows a very substantial growth, but, of course, we are still a long way behind Germany and America in tonnage, and very much below the projected capacity of the works in this country, which has been estimated, when complete, at 150,000 tons of electric steel ingots per annum.

We have dealt with the output of steel first, because so much pig-iron is only an intermediate product in the manufacture of steel. Against an increase of 556,000 tons in steel output the returns show an increase of 372,000 tons in the output of pig-iron. A comparison by grades of production made shows a marked change, and it is evidence of the successful efforts made by the Ministry of Munitions to foster the output of basic pig-iron from home ore. The output of basic pig has grown from 2,290,000 tons in 1916 to 3,082,000 tons in 1917—an increase of 792,000 tons. Against this increase of 792,000 tons in basic pig-iron, the steel output shows an increase of, roughly, 500,000 tons of ingots, so that there is a considerable discrepancy between the two figures.

The output of foundry iron has considerably fallen. Before the war we produced not less than 2,500,000

tons of foundry iron annually. Last year this quantity was cut down to about one-half. Lincolnshire, for instance, as a centre for foundry iron, has practically ceased to exist. All the blast-furnace plants in that district, with one exception, have now become allied to steelworks, and in other districts, while the decrease has not perhaps been so marked as in Lincolnshire, a change has none the less taken place.

A comparison with ten years ago shows that Lincolnshire, which then produced 250,000 tons of foundry iron, is now down to 14,000 tons, Wales from 40,000 to practically nil, North Staffordshire from 250,000 tons to 60,000, South Staffordshire from 275,000 to 118,000, and the Midland centres of Derby, Leicester, Northamptonshire and Nottinghamshire, from about 1,000,000 to 390,000 tons. To some extent the great fall in foundry iron is due to the cessation of ordinary commercial work during the war, but it is also due to some extent to the substitution for cast iron of steel castings, drop forgings, pressings and stampings, and structural steel.

The output of hematite last year was round about the 4,000,000-ton mark, where it has remained on and off for years past. It is, however, a matter of some satisfaction that, despite the U-boat campaign, we were able to maintain the hematite output at its pre-war level, depending as we do so much upon imported ores.

The actual figures of pig-iron output of the different descriptions in 1917, compared with the figures for 1916, are as follows :—Forge, 864,759 tons, as against 899,467 tons; foundry, 1,162,982 tons, as against 1,418,824 tons; basic, 3,082,562 tons, as against 2,290,549 tons; hematite, 3,993,374 tons, as against 4,042,014 tons; spiegeleisen, ferro-manganese, ferro-silicon, etc., 296,524 tons, as against 291,845 tons; direct-run iron castings, 20,053 tons, as against 105,284 tons; total, 9,420,254 tons, as against 9,047,983 tons. The Home Office statistics of pig-iron made in 1917, which we show on another page, give a total of 9,338,104 tons, as against 8,919,469 tons in 1916.

Resuming Normal Conditions.

The year 1919 opens with a more prosperous outlook than we dared to hope for a few months ago, and though there are many to whom the rate of resuming normal conditions will seem slow, the restrictions rendered necessary by the war are definitely disappearing. It is well to remember that such a vast undertaking as the late war bears no relation in its difficulties to any previous war. It was more than a military affair; it was a huge engineering feat, involving incredible quantities of apparatus and material. Now that the purely military activities have ceased, suddenly there remains to be handled and disposed of the enormous reserve of material which has drained the supplies to peace industries for several years. In common fairness to the powers that be it must be acknowledged that the sudden diversion of this material and the labour organised to use it to peace industries is not a light undertaking, and however anxious we may be to resume our industrial labours the reversion must be properly organised and controlled unless hopeless confusion and distress is to result.

The restrictions on the use of various metals have now been practically all removed, and for the guidance of manufacturers it may be as well to recapitulate the modifications in the control of materials which have been made to date by the Ministry of Munitions since the cessation of hostilities.

Ordinary civil orders may now be placed and executed in Class C without priority permits or certificates. No further application need, therefore, be made to the Priority Department of the Ministry of Munitions, unless it is desired for national reasons to raise the priority of an order. Uncomplete contracts for the Admiralty, War Office and Ministry of Munitions, which have been placed in Classes A or B, need no longer be given the priority attaching to them under the Order of Priority of March 8, 1917, except in cases where the contractor is notified in writing or by official notice in the Press that a particular classification is still required to be given to any particular contract.

Iron, steel and non-ferrous metal may be ordered, supplied and used for Class C orders without priority classfication or reference number from the Ministry of Munitions, and stocks purchased and held by Government contractors may be used for any class of work. Manufacturers of forging, stampings and castings in iron, steel or malleable iron are at liberty to accept orders for priority below Class B.

The Control Orders forbidding dealing in non-ferrous metals without a licence are suspended in the case of tin, copper, aluminium, brass (including swarf and scrap), cupro-nickel, scrap, spelter, lead, platinum, chrome ore and type metals. All restrictions as to the sale or purchase of calcium carbide have been removed subject to a maximum price to consumers of £40 per ton for quantities of 1 cwt. and over.

As to export licences, manufacturers must still continue, as hitherto, to obtain licences for export for articles made of steel and non-ferrous metals covered by the various schedules of the War Trade Department, but every effort will be made to grant these licences as freely as possible.

The maximum prices of steel for home trade are to continue at their present level until February 1, 1919, when the direct subsidies paid by the Government on steel will cease, and a corresponding increase in price takes place. A schedule of the prices to come into force on February 1 can be obtained on application to the Ministry of Munitions (C.I.S.P., Room 104, 8, Northumberland Avenue, S.W.1.). The present maximum prices of pig-iron are to remain unchanged until April 30, 1919, but post-war conditions are not yet sufficiently stable to warrant a fixing of prices after that date.

The following is a schedule of the present prices of non-ferrous metals from holdings of the Ministry :—

Copper, electrolytic, £125 per ton, buyers; *Brass Ingot*, Government specification, £93 per ton, buyers; *Spelter* G.O.B., £57 per ton, buyers; *Spelter*, refined 99.9 per cent., £61 per ton, buyers; *Aluminium*, £200 per ton, buyers; (all delivered works). *Soft Pig Lead*, £40 per ton, buyers, ex steamer or ex store; the existing schedule in relation to manufacture in lead is abolished); *Nickel*, £195 per ton, buyers, ex works or warehouse; *Antimony*, £55 per ton, buyers, ex works or warehouse. These prices are subject to usual extras for small parcels.

Restrictions as to dealing in and prices of new and second-hand machinery and treadle lathes have been withdrawn; but purchases of new machinery can only be made from firms holding trading permits from the Ministry of Munitions. Contractors in possession of plant and machinery owned by the Ministry of Munitions are at liberty to use it for civil work provided they notify the Superintendent Engineer in their area within one week from the date on which it was first used. If the contractor does not ultimately wish to purchase the machinery he will be required to pay a reasonable hire not to exceed the rate of 20 per cent. per annum on the cost price of the machine. The Crane Order of December 30, 1916, prohibiting the sale or supply of any cranes except under permit, and the Motor Engines and Vehicles Order of January 6, 1917, prohibiting the manufacture except under permit, are revoked. The Orders of March 30, 1917, prohibiting the experimental manufacture of aeroplanes, and of May 10, 1918, prohibiting the experimental manufacture of aero-engines are suspended. Owners of steam-driven lorries and trailers are no longer required to make returns of changes of ownership.

MUST WE TRADE IN TENTHS?—This is a plea against Decimal, and for Octaval Coinage, as more exactly fitting the wants and usage of all who make, grow, buy, or sell things. By Alfred Watkins. Watkins Meter Company, Hereford. 3d.

Manufacture of "Semi-Steel" Shells.

The following article and illustrations, taken from "The Iron Age," deal with a process of shell production which, during the last six months of the war, was used to a very considerable extent. The practice described is that recommended by the United States Ordnance Department, and has been effective in producing satisfactory shells.

Chemical Requirements.

Cupola-made semi-steel has been used for years in the United States and other countries in castings for a multitude of mechanical purposes, with varying steel content, according to the purpose for which intended. The very extraordinary hazards and requirements attendant upon the use of semi-steel for making projectiles compels a rigid specification for the tensile, impact and hardness tests, which is met by having quick, constant access to a reliable laboratory, experienced in analysing foundry and furnace metals and materials.

Semi-steel shell cupola mixture, for green-sand moulds, consists of remelt semi-steel 25 to 40 per cent., steel 25 to 35 per cent., pig-iron 30 to 40 per cent., the latter including ferro-silicon and ferro-manganese when used.

A cupola lined to 66 in., having a metal output of about 13 tons per hour, with 14 to 16 oz. air blast, was producing satisfactory 155-mm. semi-steel shells, running a charge of 2,000 lbs., proportioned as follows :—

	Lbs.	Silicon.	Phos.	Man.
Buffalo pig, No. 3	300	1.82	0.670	0.56
Wickwire pig No. 3	320	2.01	0.580	0.82
Steel (shell butts)	620	0.10	0.042	0.78
Remelt (semi-steel)	700	1.31	0.290	0 76
Ferro-silicon	50	12.00	0.070	0.00
Ferro-manganese	6	—	—	80.00
Laboratory analysis*	—	1.19	0.300	0.73
Calculated analysis	—	1.39	0.310	0.98

* Combined carbon, 0.74%; graphitic carbon, 2.40%; total carbon, 3.14%; sulphur, 0.117%.

The foregoing example of elements of cupola metals will also serve as a guide for a mixture when using a reverberatory melting furnace. The range of the analyses of metal in the castings made from the above mixture was, in percentages, as follows :—Silicon, 1.10 to 1.30; phosphorus, up to 0.35; manganese, up to 1.00; sulphur, 0.08 to 0.12; combined carbon, 0.60 to 0.70; graphitic carbon, 2.40 to 2.60; total carbon, 3.10 to 3.20; silicon plus total carbon, 4.40.

For green-sand moulding semi-steel must be very fluid, extremely hot, and not in the least dull, because it must liberate its gases. On account of the lower carbon content semi-steel has a tendency to become sluggish when dull, so it must be handled rapidly and at a high temperature.

The Cupola, the Charges and Melting.

In order to attain the above requirements the cupola must be attended more carefully than with grey iron, a larger percentage of coke must be used, and the cupola-charging practice followed closely. A cupola accustomed to producing hot grey iron need not be altered in any way. It is important that the charges be as small as is consistent with keeping a definite layer of coke between the charges. The steel mixes with the iron better when this practice is followed. The charges must be placed level and uniform throughout—charging the steel after the flux directly upon the coke, and following with the pig-iron and the remelt. When large charges are used, the quantity of steel, pig and remelt being greater, they do not mix so completely as do the smaller charges. It is advisable to flux the cupola continuously, using generous quantities of flux. For a 2,000-lbs. metal charge in a cupola lined to 66 in., 250 lbs. of limestone evenly distributed on top of the coke works out satisfactorily.

The first metal from the cupola is not suitable for pouring shells; it is usually weak and does not stand the tensile nor the impact tests. It should be poured into other work or be pigged and the pouring ladle drained before beginning to pour shells. Scrap steel should be used in small pieces in the first charge, as it melts more easily. The iron will always melt first. Maintaining a layer of slag in the cupola helps to desulphurise the drops of molten metal while straining through it.

It is essential to use a large mixing ladle, as this ensures a much more uniform semi-steel mixture. A bottom-pouring mixing ladle of the "teapot" type is greatly to be preferred, as it pours clean metal. Large pouring ladles are also preferable, as the metal keeps its temperature better when handled in volume. A reverberatory melting furnace instead of a cupola can be used, provided it ensures the production of a homogeneous melted mixture.

Metal-Working Core-Forming Boxes.

The accuracy of contour, dimensions and location required of the shell interiors compel the use of a method for making metal-working core-forming boxes that will invariably produce these requisites. A method in satisfactory use is as follows :—

Wood patterns are made for producing the metal master core-box pattern, which is cast in several pieces (Fig. 15), each piece having sufficient additional stock for machining. The pieces are planed, bored (Fig. 2) and assembled, forming a two-piece master core-box pattern. One piece, the inside half of the pattern, is then permanently attached to one side of a trued wood match plate; the other piece, the outside half, is attached to the other side (Figs. 3 and 4). These two views also show the two halves of a finished mould for pouring a working core-box.

Working Core Box and Core Arbors.

The working core-box is cast with sufficient stock to enable facing of the two halves and the nose end (Fig. 5), and boring the anchor hole which takes the core-arbor shank. The recess in which the core is formed is not machined, but is scoured sufficiently to remove roughness or slight projections (Fig. 6). On one half of the working core-box are cast trunnions to enable swinging it in a wooden frame or yoke when hand-ramming a core. To the same half of the core-box are hinged four swinging clamps with which to clamp it to the other half of the box.

Fig. 7 shows a type of semi-steel shell core-arbor in use. It consists of a piece of pipe, one end of which is drawn to a blunt open end, the nose of which is about one-third of its regular diameter. Near the other end is shrunk a collar. This end is then turned and ground to a close sliding fit in the drilled and reamed anchoring hole, in the working core-box (and in the flask). The collar is also faced on the under side. This face constitutes

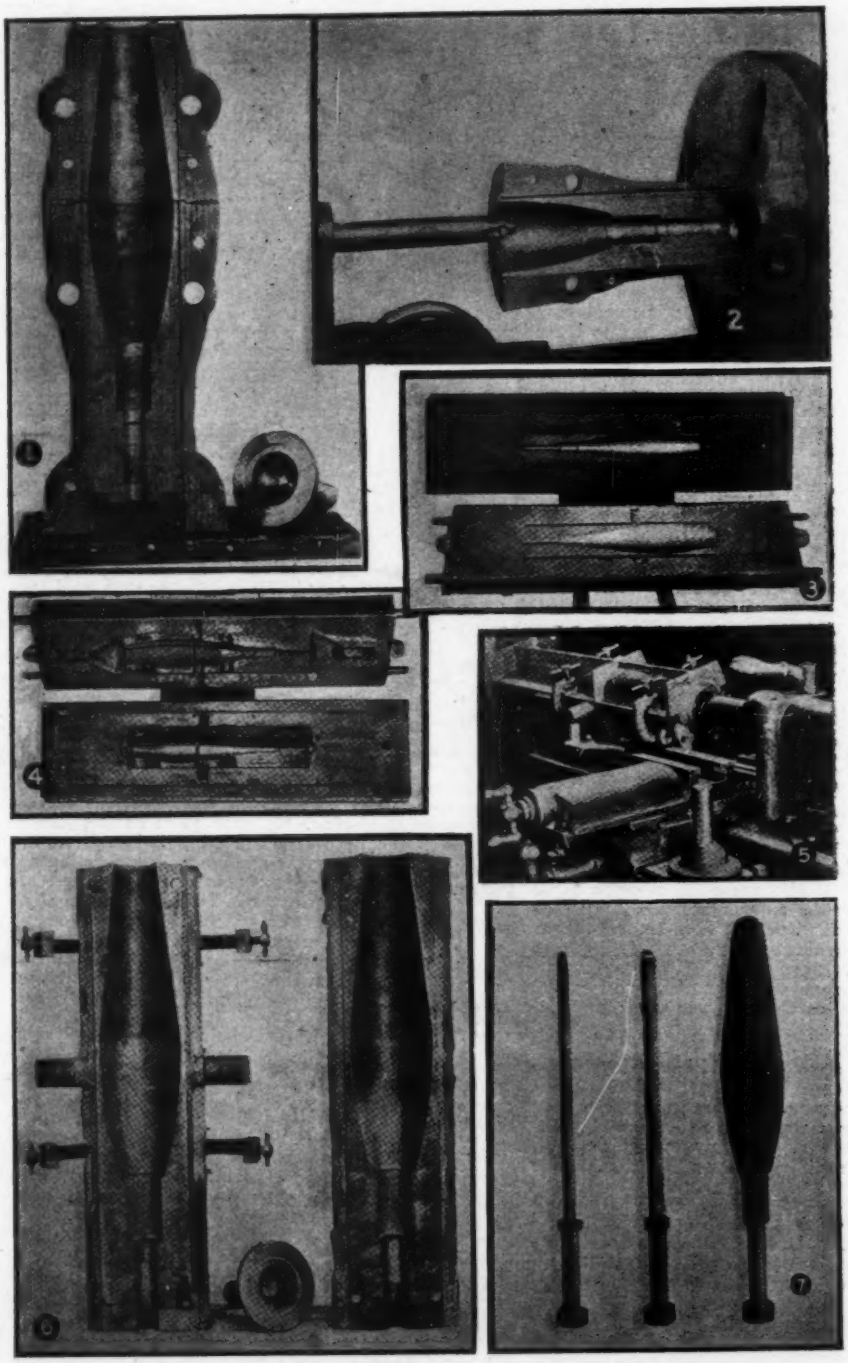


Fig. 1.—Iron Working Patterns for Core Box, showing Joint which allows for Machining. Fig. 2.—Turning inside of Pattern for Core Box with the use of Profiling Attachment. One-half of Box removed. Fig. 3.—Pattern for inside half of Core Box and finished half of Mould. Fig. 4.—Pattern for outside half of Core Box and finished half of Mould. Fig. 5.—Turning end of Working Core Box to take loose piece which forms round Nose on Core. Fig. 6.—Core Box of two halves and loose piece to form round Nose on Core. Fig. 7.—Core Arbor Plain. Core Arbor wrapped with Burlap, and finished Core ready for the Foundry.

FIG. 8.—Core Truck with Cores hanging instead of standing up. Trucks are being fitted up so that all Cores can be dried standing up. FIG. 9.—Ramming up Core Box. Two halves of Core Box standing in front of bench. FIG. 10.—Core Box in a horizontal position. Drawing half of Core Box. FIG. 11.—Core Box turned over and Core being removed from Box. Rap box lightly with stick while Core is being drawn. FIG. 12.—One-half of Core Box and Core removed. FIG. 13. —Rack for carrying Cores from Core Room to the Foundry. FIG. 14.—Lowering Core into Mould. The Moulds at left of picture are completed. FIG. 15.—Box used for making Core for Cope End Dry Sand Core. This Core acts as a Strainer while pouring.

the "stop" when the shank end of the core-arbor is inserted into the anchor holes of the core-box and the flask. The upper face supports the end of the core. The machined shank end of the arbor is threaded to take a nut which is used to draw the arbor to "position" in the core-box and flask anchor holes. "Position" constitutes *contact* of face of collar with face of anchor holes.

The nut on the core-arbor also enables hanging the cores vertically on core trucks (Fig. 8). The portion of the arbor enveloped by the core contains a number of holes, approximately ¼ in., over which is spirally wrapped a thickness of scrap burlap to prevent the holes from becoming plugged with sand. This burlap carbonises upon pouring, and ensures easy withdrawal of the arbor from the casting.

Core Sand and Binding Mixture.

The following sand mixture produces a tough, porous, smooth semi-steel shell core which vents well and stands handling:—Selected fire sand or pure silica sand; ground fire clay; No. 1 new moulding sand; sawdust; molasses; water. A typical batch comprises the following proportions:—

One box 12 in × 12 in. × 10 in. fine sand.
One box 12 in. × 12 in. × 3½ in. ground fire clay.
One box 12 in. × 12 in × 3 in No. 1 moulding sand.
One box 12 in × 12 in. × 1½ in. sawdust.
One pint molasses.
Two quarts water.

All should be very thoroughly and uniformly mixed in a rotating sand-mixing machine.

Hand-Rammed Cores.

Insert core-arbor into the anchor hole of the half core-box which is suspended horizontally, by trunnions cast thereon, in a yoke frame. Situate the other half of core-box. Turn nut on shank until arbor is drawn to "position." Clamp the halves together securely. Turn core-box to a vertical position. Feed in a small quantity of sand. Ram this neck part of the core very hard, using a piece of bar iron ½ by ½ in., or a similar piece of hard wood. Feed more sand, meanwhile ramming until full (Fig. 9). Run a vent wire down through core, parallel with arbor, three times uniformly spaced. Be careful not to allow vent wire to come in contact with the sides or neck of the box. The holes left by the vent wire are closed in at the top and tacked down with fingers and three eightpenny nails inserted. A separate round iron end shape is then secured to the upper end of the core-box through a hole in which a small additional quantity of sand is rammed with a small rammer fashioned for the purpose or with the fingers. A small round iron plug-shaped piece is then pressed into the hole to ram into shape the extreme tip of the core.

Withdraw this plug and with it lightly rap the iron end shape piece, drawing the same away from the box. Turn the core-box to a horizontal position, unclamp, rap and draw upper half of the box (Fig. 10). Turn core-box to a vertical position. Unscrew arbor nut about one turn. Grip nut firmly with one hand, turn core-box slightly beyond vertical and lightly rap core-box and the core will swing clear of the box (Figs. 11 and 12). Still gripping the nut, gently hang the core, suspended by the nut, in the rack on the core truck (Fig. 8).

Bake three hours (for a 155-mm. shell core) in a temperature of approximately 450 deg. Fahr. When cool, dip in a wash comprising three parts triple X mineral facing and one part best plumbago, stirred into a regular clay wash, using Jersey clay and water. Thoroughly agitate during dipping. Shortly thereafter, again dip the butt end (the end opposite the threaded end) for about 4 in. The core is then again hung on the same core truck and placed in the oven at the same temperature and baked for another hour. After a second drying the cores are taken from the truck and the nuts removed. The cores are stacked on a carrying rack, shank end downward, through holes provided in the deck of the rack (Fig. 13), and carried to the foundry floors.

Moulding Semi-Steel Shells.

The use of one-shell flasks or multiple-shell flasks is principally a question of foundry equipment. The one shell or one-piece flask is placed on a jarring machine. A metal shell pattern, having a shank on its nose end of exactly the same size and close fit as the shank on the core-arbor, is placed in the flask, the end of the same taking a nut the same size as used on the core-arbor, which is set up hard by hand. Sand is then fed into the flask and rammed. A number of holes are then made with a vent wire in the mould parallel with the sides of the pattern to facilitate the venting. Remove nut from shank of pattern, draw pattern from mould and very thoroughly veneer the mould with plumbago by shaking in a quantity and then inserting a blow-pipe for the purpose of spreading the same. This is to minimise cleaning labour. Lower core in mould by hand (Fig. 14), machined end of arbor entering anchor hole. Screw nut home on lower end of arbor to securely hold core in absolutely central position during the pouring of the metal.

A cast-iron pouring box is now placed on top of the flask and made fast with two clamps and clay or moulding sand placed around the joint to prevent run-outs while pouring. In this pouring box (Fig. 15) is placed a slab of baked core sand for a strainer gate. It is perforated with a number of small holes (the 155 mm. has eight ⅜-in. holes) accurately located to cause the metal to feed into the mould, in a number of small streams without dropping against either the side of the core or the mould, and striking the mould near the nose of the shell. The baked core sand strainer also ensures feeding clean metal to the casting. It also includes a vent stack riser enabling the gas to flow freely from the mould.

The space between, about 1½ in., this baked core sand and the sides of the pouring box is filled and rammed with moulding sand. As soon as the core has stopped venting after the pouring, remove the nut from the core-arbor and allow the casting to remain in the flask at least four hours before shaking out. In shaking out care must be taken to draw the casting straight to prevent injury to the core-arbor shank.

Cleaning the Shell Castings.

Among the many ways to clean the shell inside and outside, sand blasting is recommended, as it is rapid and effective and minimises handling. Sand-blasting apparatus provided with special jets is available for this purpose.

The next step is the cutting off of the riser and rough trimming the nose, best done with a cutting-off machine, leaving ample metal for the machining operations. The illustrations (Figs. 16 to 32) show a consistent progression of machining operations entailing minimum handling.

Fig. 16—Center Base. Vertical Drill Press. Vertical Expanding Mandrel. Time, 2 Minutes. Note—Base and Nose of Shell Roughly Trimmed and Shell Cleaned in Foundry

Fig. 17—Drill Driving Holes in Base. Vertical Drill Press Jig with Center Stud to Locate Holes. Time, 2 Minutes

Fig. 18—Gage and Mark Nose Relative to Inside Bottom, Plus 1/16 In. to Finish. Hand Operation. Special Marking Gage. Time, 1 Minute

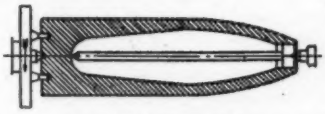


Fig. 19—Cut Off Nose End to Mark, Allowing 1/16 In. to Finish, Bevel Inside Edge 1/32 In. for Center. Engine Lathe. Mandrel in Nose with Fixed Center. Time, 3 Minutes

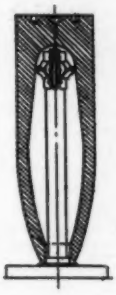


Fig. 20—Recenter to Exact Depth Relative to Inside Bottom. Vertical Drill Press, Expanding Mandrel and Face Plate, Automatic Drill Stop. Time, 1 Minute

Fig. 21—Rough Turn Body and Profile. Lo-swing Lathe, 24 In., or Engine Lathe with Profile Attachment. Plug Center. Time, 10 Minutes.

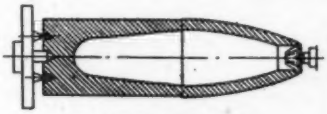


Fig. 22—Finish Turn Body and Profile. Lo-swing Lathe, 20 In., with Profile Attachments. Plug Center. Time. 10 Minutes

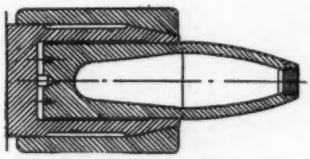


Fig. 23—Bore Nose, Face and Thread to Exact Length Relative to Inside Bottom Stop on Base Center Turret Lathe, 24 In., with Hex. Turret, Hollow Spindle for Collet Chuck. Time, 10 Minutes

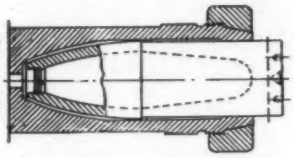


Fig. 24—Nose Centering Plug, Cutoff Base. Cutoff Machine. Collet Chuck, Double Tool Post. Time, 5 Minutes

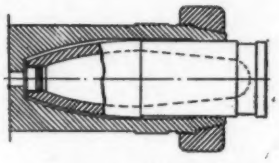


Fig. 25—Band Groove and Undercut Collet Chuck with Nose Stop. Time, 4 Minutes. Note—If Lo-swing Lathe Is Used on 19 and 20 this Operation Can Be Done Simultaneously

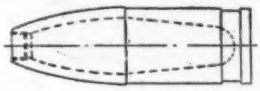


Fig. 26—Weigh and Mark. Automatic Scale and Special Marking Gage. Time, 1 Minute

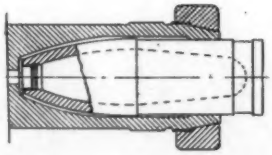


Fig. 27—Finish Base and Chamfer Facing Machine. Time, 4 Minutes. Note—Groove Base for High Explosive Shell

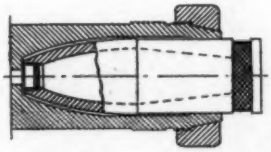


Fig. 28—Knurl Band Groove. Knurling Machine Time, 2 Minutes

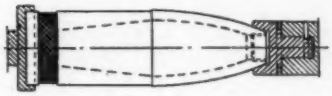


Fig. 29—Grind Bourrelet. Plain Cylindrical Grinder. Special Head and Tail Stock Fixture Operated by Foot Lever. Time, 2 Minutes. Note—Air Test

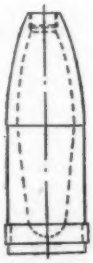


Fig. 30—Copper Band Applied Banding Press. Time, 1 Minute

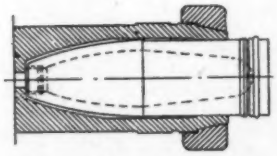


Fig. 31 — Copper Band Turned. Band-Turning Lathe with Collet Chuck. Time, 2 Minutes. Note—Hydraulic Test and Dry After Band Is Applied High Explosive Shell Apply Base Cover After Test and Drying.

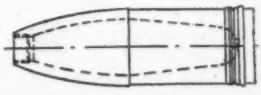


Fig. 32—Paint Shell For High Explosive Shell Only, Varnish Inside. Time, 2 Minutes

The Possibilities of a Cheap Microscope.

By H. Spencer Kipling, F.C.S.

To the uninitiated, the subject of the internal structure of a metal is so hedged around by terms of many syllables that they abandon all idea of making practical use of it. The writer proposes to show that the matter is far more simple, and requires far less expensive apparatus, than appears at first view.

In the first place, whilst a hundred-guinea outfit is a great convenience if research is attempted, it is far from being essential. It is surprising what satisfactory work can be done using the familiar 21s. microscope of our school-days. This simple instrument can probably be promoted from the observation of "cheese-mites" to that of metals, if certain simple appliances be added. The writer on a previous occasion has pointed out the value of certain easy tests and detailed the methods of making them. (FOUNDRY TRADE JOURNAL, July, 1914.)

It is not always possible to avoid defective castings, but mysterious failures are often explained by microscopic examination, thus paving the way to their avoidance in the future. The article referred to above described methods for estimating the approximate percentages of sulphur and phosphorus in cast iron, but it is quite possible to have an ideal composition and get a rotten metal. This is where the microscope becomes our valued assistant, for an overheated metal reveals its condition under comparatively low magnification—well within the limitations of the cheap instrument mentioned. It all resolves itself into a question of experience and comparison. If a certain casting is poured too hot and another too cold these will act as "limit-gauges" if similar sections are cut from them, and the condition of any casting can then be deduced, according as it approaches the appearance of one or the other.

Very rarely is it necessary to have a better finish than that produced by dead-fine emery paper, and this finish can readily be attained by hand without resort to the polishing machines figured in catalogues. When a lustrous polish is essential it is quite feasible to produce it by hand on a piece of cloth charged with rouge, but it is a long process, and a home-made machine is not difficult to make. The writer has seen an excellent one consisting of an old cycle hub and spindle—which cost 6d. at a marine stores—clipped to the edge of a bench by an iron band, and having a wooden combined table and pulley mounted on the spindle driven off an overhead shaft by a round belt. Having produced a surface suitable for the purpose in hand, we can proceed to examine it.

In the case of cast iron, the polished surface itself reveals the structure, as the graphite plates need no development. From their size and arrangement the strength and general nature of the iron can be judged. If they are large and numerous the iron is soft and probably high in silicon, but if small and relatively less in bulk the iron is hard in nature and probably low in silicon.

Having completed observations on the polished section, it may then be etched to develop its internal structure more fully. For this purpose dilute nitric acid—about 5 per cent.—is a simple and satisfactory reagent, although certain of the more complex solutions produce better micro-details. After etching the section, careful examination will show if any tendency to chilling has existed, and equally, of course, if the metal tends to be too open, more delicately than is exhibited by the arrangement of the graphite.

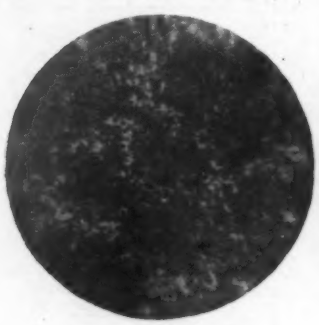


FIG. 1.—CAST IRON No. 1; × 25 DIA.

FIG. 2.—CAST IRON No. 2; × 25 DIA.

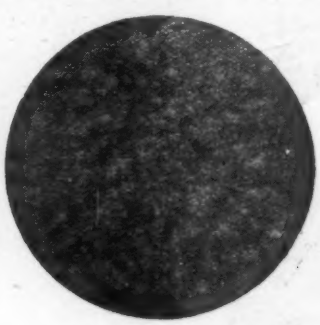


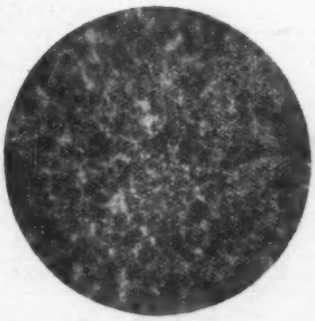
FIG. 3.—CAST IRON No. 3; × 25 DIA.

The structure of the pearlite may range from coarse and brilliant lamellea to a minute and sorbitic form, each type having as its origin a distinct set of circumstances as to composition, casting temperature and rate of cooling.

In the case of other metals, different etching procedure may be necessary, although the structures of most metals are developed by nitric acid. Aluminium is best etched by dilute hydrochloric acid, the degree of dilution necessary ranging according to the composition of the alloy. Much, too, can be done by the beautiful and simple process of "heat-tinting" (although much care and a certain amount of skill are necessary to secure good results). This consists simply of producing "temper-colours" on the polished section by cautiously heating it. The various constituents colour at different rates so that they may be readily distinguished from each other. It is applicable to all materials which colour or "tarnish" upon heating, and important deductions can often be drawn from an examination of the section

thus treated. Dr. Stead has developed this method and has published many excellent micrographs of specimens thus prepared.

For very low-power examination no special illuminating arrangements are necessary, but when higher degrees of magnification are employed it becomes necessary to consider ways of directing suitable beams of light upon the specimen under examination. A small electric light is a good source of light. If such is not available an acetylene cycle lamp is very satisfactory, though not so convenient as the other. A bulls-eye lense to concentrate the light is desirable, though not essential, if low magnifications are used.



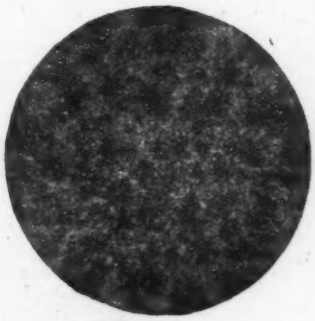


FIG. 4.—CAST IRON NO. 4; × 25 DIA. FIG. 5.—CAST IRON NO. 5; × 25 DIA.

For many purposes oblique illuminations (that is to say, a beam coming from one side of the section at an angle) is sufficient; for others a vertical light is essential. This effect is achieved by fixing a thin piece of glass at an angle of 45 deg. to the axis of the microscope in the tube above the objective and directing a beam of light upon it. The light is reflected down through the objective, again reflected from the surface of the specimen up through the lenses to the eye.

The simplest way is to make a saw-cut into the tube at an angle of 45 deg. to its axis, and then drill a hole opposite to it for the entry of the light. Into the same saw-cut is dropped a "cover-glass" (used for protecting mounted micro-sections) which then acts as a reflector whilst allowing clear vision through it. The effect is exactly similar to that noted in a fire-lit room towards dusk, the image of the fire appearing on the window, whilst it is still possible to see outside objects plainly.

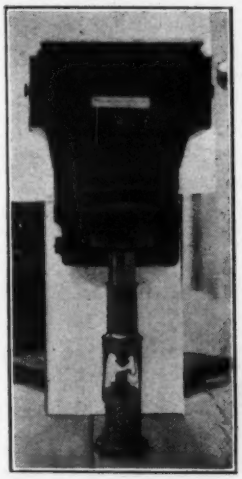


FIG. 6.—APPARATUS USED, SHOWING GLASS REFLECTOR BELOW OBJECTIVE.

When the focus of the lens is long enough to admit it, a simple method is to fix the reflecting glass below the objective. This was the method adopted in the present apparatus, a wire clip being soldered to the mount of the objective to hold the cover glass.

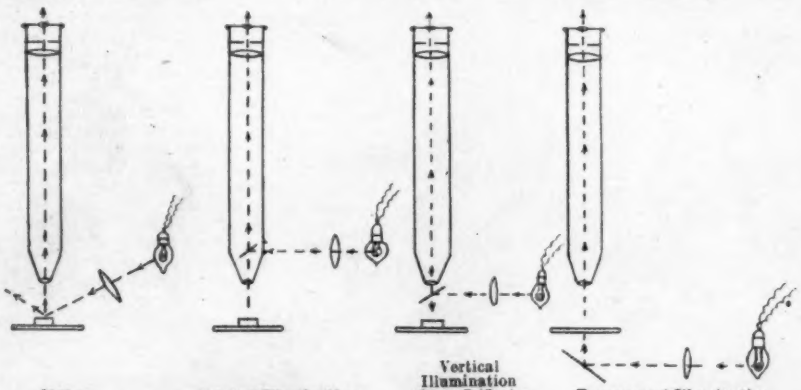

Oblique Illumination.
Vertical Illumination (Glass Reflector in Tube).
Vertical Illumination (Glass Reflector below Objective).
Transparent Illumination (Mirror below Specimen).

FIG. 7.—SKETCHES ILLUSTRATING METHODS OF ILLUMINATING SPECIMENS.

Transparent objects are illuminated by reflecting the light through them by means of a mirror below them. The accompanying sketches show the various methods of illumination referred to above.

Another class of material which may be examined profitably is sand. In this case illumination in all three ways can be employed and very useful information obtained. Recent publications have illustrated types and conditions of

sand, and this information should be supplemented by careful consideration of the local supplies and conditions.

Apart from the business value of the subject, it is of considerable fascination as a recreation. One mystery solved proves a rung in the ladder needed to surmount some difficulty, and gradually half-understood facts become definite and useful assistants, leading on to the ever-distant point of perfection.

The structures observed can readily be recorded photographically. All that is necessary is to fix a camera above the microscope so that the instrument replaces the normal lense. The magnification possible depends upon the perfection of the lenses and the intensity of illumination available. Small amplification is, however, all that is usually required, and 25 or 50 diameters quite enough.

The micrographs of cast-iron samples accompanying this article were obtained by the use of the apparatus shown in the photograph and show the possibilities of the instrument. They are not good micrographs, compared to those obtained by means of better lenses, etc., but are quite good enough as records of the general structures of the samples examined. It is to be remarked that these micrographs are the only trials made, and, therefore, represent the results to be obtained at the first attempt with this type of apparatus.

The writer is fortunate enough to have control of a very thoroughly equipped research laboratory, and his normal working appliances are widely removed from those described in this contribution; but it cannot be too strongly emphasised that low magnification and carefully cultivated powers of observation are all that are required in general work of the routine type. Oil-immersion lenses of high magnifying power are necessary at times, but only to supplement the evidence of the lower-powered lense.

Compositions and Descriptions of Cast-Iron Samples.

Number of micrograph.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Silicon	1.37	1.79	2.68	2.33	1.46
Sulphur ...	.169	.156	.115	.160	.172
Phosphorus ..	.780	.499	1.014	1.042	.810
Manganese ...	.45	.78	.33	.49	.54
Combined carbon	.91	.54	.49	.56	.86
Graphite ...	2.23	1.90	2.97	2.49	2.00
Total carbon ...	3.14	2.44	3.46	3.05	2.86
Conditions of casting.	Hot metal, cast in green sand		Cool metal cast in chill.	Hot metal cast in chill,	Cool metal cast in green sand.

Manufacture of Ferro-Molybdenum.

Mr. Robert M. Keeney, in a Paper recently presented to the American Institute of Mining Engineers on "The Manufacture of Ferro-Alloys in the Electric Furnace," states that the raw materials used in the preparation of ferro-molybdenum may be :—For ore, the sulphide, molybdenite, or sodium molybdate slag made from wulfenite; for reducing agent, some form of carbon, or 90 per cent. silicon metal ground to pass 60 mesh; for fluxes, lime and fluorspar. There are two methods of manufacture :—

(1) Reduction with carbon and excess of lime, according to the reaction :—

$$2MoS_2 + 2CaO + 3C = 2Mo + 2CaS + 2CO + CS_2$$

Pure molybdenite contains 60 per cent. molybdenum and 40 per cent. sulphur. According to the above reaction, 100 parts of molybdenum are reduced from 170 parts of molybdenite by 18.8 parts of carbon. For every 100 parts of molybdenum, 58 parts of lime are necessary for slagging the sulphur as calcium sulphide. This reaction works out closely to the theoretical, and there is no difficulty in making a product with about 0.1 per cent. sulphur; the product will contain 1.3 to 3 per cent. carbon. If a lower-carbon alloy is desired, the crude metal is broken up and refined with an oxidising slag of iron ore. The amount of iron in the alloy is varied as desired by the addition of iron turnings in the smelting furnace, or of iron oxide in the refining furnace.

(2) Reduction with silicon metal, according to the reaction :—

$$MoS_2 + Si = Mo + SiS_2$$

This method has been used recently in the production of 50 per cent. ferro-molybdenum, although when this grade is being made ferro-silicon may be used. Lime is sometimes added to help to slag the sulphur as calcium sulphide. By this method the production of 100 parts of molybdenum requires 29 parts of silicon. When sodium molybdate slag is the source of molybdenum, reduction takes place according to the reaction :—

$$Na_2MoO_4 + 3C = Mo + 3CO + Na_2O$$

The use of sodium molybdate requires considerably more power than the other reactions, because very little reduction occurs until all free soda salts which may be in the slag are driven off. The regular grade of sodium molybdate slag used for this purpose contains 30 to 40 per cent. MoO_3. In all electric furnace work the presence of sodium salts interferes with the speed of the reactions.

The average wulfenite from which ferro-molybdenum is produced contains :—MoO_3, 16; lead, 50; SiO_2, 6; FeO, 11.0; CaO, 2.0; arsenic, 0.8; phosphorus, 0.05 per cent. This concentrate is smelted in a circular, water-jacketed lead blast furnace with coke and soda ash to produce lead bullion and molybdenum slag. The slag contains: MoO_3, 33; lead, 1.0; SiO_2, 11 to 14; FeO, 17; CaO, 7; arsenic, 1.0; phosphorus, 0.1 per cent.; remainder, soda. This molybdenum slag, crushed to about ½ in., is smelted in single-phase electric furnaces of the Siemens type, lined with magnesite to produce ferro-molybdenum. The charge is calculated to a mono-silicate slag, using lime as a flux. Iron ore is added to produce an alloy containing 60 to 65 per cent. molybdenum, and residues from an oil-gas plant are used for reducing agent.

The average power consumption is 7 to 7.5 kw.-hr. per lb. of molybdenum produced. The recovery varies from 78 to 80 per cent., with a loss of 10 per cent. in slag, and about 10 per cent. mechanically and by volatilisation.

Analysis of Ferro-molybdenum made from Sodium Molybdate Slag.

	%	%	%	%	%	%
Molybdenum ...	61.0	62.34	66.96	64.78	62.35	62.02
Carbon	2.31	2.214	2.03	1.51	1.91	1.29
Silicon	0.41	—	—	—	—	—
Phosphorus ...	0.086	0.018	0.029	0.018	0.040	0.13
Sulphur	0.098	0.075	0.060	0.022	0.049	0.03
Arsenic	1.10	—	—	—	—	—
Copper	0.018	—	—	—	—	—
Manganese ...	0.2	—	—	—	—	—

Ferro-molybdenum containing 90 per cent. molybdenum and under 1 per cent. carbon cannot be regularly tapped from the electric furnace because of its high melting point, so that when this grade of alloy is to be made, the furnace must be of the knock-down variety, for removal of the button. The slag is tapped off, and when this operation is finished, the metal is dug out. A 50 to 60 per cent. low-carbon product can be tapped, and a considerable quantity of this grade is made in tapping furnaces.

Production of Solid Steel Ingots.

On Thursday, December 19, the Birmingham Metallurgical Society and the Staffordshire Iron & Steel Institute held a joint meeting at the Chamber of Commerce, Birmingham, under the presidency of Mr. I. E. Lester (President of the Metallurgical Society), when a Paper was read by MR. J. E. FLETCHER, of Dudley, on "Mechanical Methods used for the Production of Solid Steel Ingots."

The author pointed out that the subject of sound steel-ingot production had recently been very generally discussed by metallurgists and engineers, whose conclusions might be summarised as follows:—(1) That unsound steel is due to the presence of occluded gas bubbles and so-called shrinkage cavities, and of oxide, sulphide, and phosphide inclusions. (2) That such unsoundness can be remedied, at least partially, by providing a refractory-lined feeding head at the ingot top which, being kept hot and liquid by means of fluid slag, charcoal, coke, or burning gases, by thermit action, or by electric arc, secures that the top 10 to 15 per cent. of the ingot remains molten, whilst the freed gases can escape into it, the molten steel feeding the ingot centre, which otherwise would contain the gas or shrinkage cavity or pipe. (3) That when steel is properly made in the furnace the minimum of deleterious gases and segregates remain in the ingot, a freely piping steel resulting which, with efficient hot top or feeder, is located only in this waste head which need not exceed, say, 10 per cent. of the total weight of the ingot. (4) That mechanical methods for overcoming the piping trouble in ingots, unless of a simple, effective and cheaply operated nature, are unnecessary.

In spite of the last conclusion, the author suggested the possibility that there may be even yet a place for mechanical methods which can assist the proper crystallisation of steel masses by promoting a more homogeneous crystalline arrangement, and in preventing the harmful mass segregation of oxides, sulphides, silicates, and phosphides at positions in the ingot which may afterwards become points of vital importance in the final forged or rolled product.

The author remarked that the Sheffield practice of Huntsman's days still holds the field for the production of small steel ingots of uniform quality suitable for making tools, cutlery, and the like. By means of excellent limelight illustrations, the author described the various methods, commencing with Hollingdrake's method in 1819, when compression of liquid steel was secured by top pressure from a piston. In those days no one dreamt that gases could be dissolved in liquid steel, and many of the old ingots were so honeycombed as to look like a sponge. At that time it was believed that all gas existed as free bubbles which might possibly be withdrawn by vacuum methods or squeezed out by pressure. Regarding the chemical processes taking place in liquid steel, the author pointed out that practically no success had attended the various processes of extracting gases at the top of the ingot by pumping or vacuum methods, and no real advance was made until hydraulic pressure was applied endwise to the ingot in the liquid state.

Attention was given to the Harmet, Illingworth, Robinson, Rodger, and Talbot systems, all of which were described in detail. Other systems included the Brearley patents, devices by MacDonald and Cuinot for rolling ingots before complete solidification, and the Talbot method, in which the same principle is carried to much greater perfection. On such systems the author remarked that it would seem probable that any extrusion method employed on soaked ingots would be attended with difficulties of ring segregation, though the recent laterally pressed ingots of Mr. Talbot moved the segregate ring well towards the ingot top, where its influence was not so dangerous, as a small discard would remove it. The device by Messrs. H. W. and H. Brearley for casting small ingots of about a ton in weight appeared to meet many theoretical and practical requirements.

The author, in his general conclusions, pointed out that the study of mechanical methods for producing sound ingots brought into prominence the all-important question of mass heating and cooling, and its influence on the crystalline structure of steel. Further, if the chemical analysis was unsuitable, then included gases, whether in the free state or occluded, were inevitably present. The only really sound steel was a freely piping one, and to obviate the loss attending the formation of pipe, either hot feeder heads or some mechanical method for eliminating the pipe, or a combination of the two, must be adopted. The feeder head applied to an ingot cast in a sand mould produced a coarsely crystalline interior inseparable from slow cooling from the molten state. This was the weakness of a feeder head ingot, for, though the later re-heating for forging or rolling would break up the crystalline structure, it would not destroy entirely the original crystal boundaries. While heat treatment could mask these, and bring about an interlocking of the smaller crystalline units, it was very questionable whether this was definitely permanent. Sir Robert Hadfield had repeatedly advised the use of the small ingot as against the large one, and there was good ground for the statement that an ingot which had an originally fine crystalline structure would produce a better forging with relatively few reductions than would a large ingot with many.

A discussion followed, in which the President suggested the necessity of much further investigation with regard to the presence of oxygen in steel.

Replying to the various speakers, the AUTHOR said there was a good deal of evidence of the persistence right to the end of the original material, just as hot-blast pig-iron preserved right to the end totally different characteristics to those manifested in cold blast.

Oil Furnace for Melting Pig-Iron.

Our illustration shows a German tilting, horizontal, tubular furnace, oil-fired, and of the non-crucible type, is described in a recent issue of "Stahl und Eisen," for melting grey pig-iron for castings of superior strength. It has been patented by Herr August Diefenthäler. This type of furnace was originally used for melting non-ferrous metals, but it gradually found its way into steelworks for melting ferro-alloys, and is now being introduced in increasing numbers into iron foundries also.

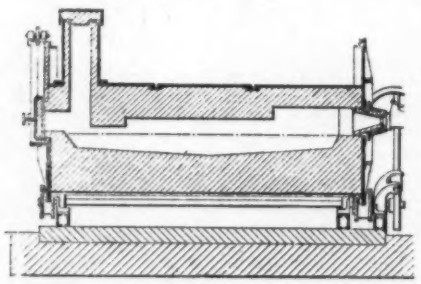
The illustration shows a longitudinal section from which it will be seen that the furnace consists of a cast-iron drum, lined with refractory material, which can be tilted through a quarter turn by a hand-wheel and gearing. (Part of this can be seen on the right in the illustration). The charge is put into the furnace through a low circular shaft (not shown) placed eccentrically in cross section at the middle of the drum. This shaft is filled to the brim with the pig-iron and scrap to be melted down, and thus acts as a pre-heater, the flame issuing from it. As soon as the charge is melted down a lid is placed on the shaft and the gases then escape through the chimney to be seen on the left. The chimney also has a lid with a small hole in it. A mixture of oil and air is blown into the furnace through an opening (on the right in our illustration), and it is recommended to have always a shortage in the air supply, so as to create a non-oxidising atmosphere in the furnace. The free formation of soot will indicate a shortage in the air-supply.

A melting will take about two hours, so that with a ½-ton furnace about 4 tons of iron can be dealt with in a day. The molten iron will be highly liquid, and can

be used for thin castings. It takes an hour to heat up the furnace, but the time can, of course, be shortened if the furnace is kept at work steadily. The velocity of the firing mixture, as it leaves the burner should be so regulated as to produce the maximum pressure of about 1.2 in. water gauge. Any increase or decrease in the initial velocity will reduce the pressure. At any rate, this was the writer's experience with his furnace. The most suitable speed of the firing mixture must depend on the cubic contents of the furnace. The cost of a whole plant for dealing with a charge of 0.5 to 0.6 metric ton should not exceed £250 to £300, as far as estimates will hold good at the present time. The furnace will be found very useful as an adjunct to the cupola. In foundries where non-ferrous metals are dealt with, besides pig-iron and scrap, it is well to have two or more drums and put them into commission as required.

The author warns his fellow-workers that the working costs per unit weight of metal dealt with in the tubular furnace are higher than when melted down in a cupola, as the former burns more fuel in proportion, and the refractory lining also wears out more quickly. The quantity of oil fuel required is about 15 to 20 per cent. of the weight of the metal charged into the furnace. With oil-fuel costing about £6 5s. the ton, the fuel cost will be about 19s. to 25s. per ton of charge, that is about 3.6 to 4.7 times of the fuel cost for a cupola, assuming a consumption of coke in the latter case of 12 per cent., and the price of coke as 44s. per ton. Besides this higher fuel cost, there is also the increased cost of maintenance of the refractory lining, the renewal of which, in the case of a furnace of 0.5 to 0.6 ton capacity, will run to about £10 to £12 10s. The life of the lining will depend on the additions of steel scrap, say, 15 to 20 tons. Special refractory material will, of course, prolong the life, but the cost of the lining will, in any case, not fall much below 13s. per ton of metal. The average working cost for oil fuel and lining alone will, therefore, be about 35s. per ton of molten metal. One man will be sufficient to attend to the furnace, besides doing other work.

The higher working cost, however, will be fully justified by the higher quality and strength of the castings. The Brinell hardness of castings made with the



Section of Oil Furnace for Melting Pig-Iron.

furnace varied from 100 to 115 tons per sq. in.; the tensile strength between 13.78 tons and 19.05 tons per sq. in., the deflection between 0.39 in. and 0.53 in., and the ultimate "bending strength" between 25.14 tons and 33.97 tons per sq. in. It should be explained here, that in German standard practice the specimens for the tensile and the lever tests are cast round, and tested "as cast" with the skin on. The tensile specimens are 0.8 in. in diameter, the pieces for the lever test 1.2 in. in diameter. The latter are tested on bearings 23.6 in. clear apart.

The charge consisted of 5 to 10 per cent. of steel rail scrap, 20 per cent. hematite, and the balance of foundry pig, Nos. 1 to 3 (German grading), and scrap iron. The chemical composition of the cast-iron varied between the following percentages:—Total carbon (4 specimens), from 2.45 to 3.26; graphite (2 specimens), 2.35 and 2.36; silicon (12 specimens), 2.41 to 3.00; sulphur (12 specimens), 0.062 to 0.12; manganese (11 specimens), 0.28 to 0.50; and phosphorus (11 specimens), 0.40 to 0.51. The loss of silicon, owing to the high temperature of the metal when poured, and the low manganese content, was 15 to 20 per cent. There was no loss of manganese at all, or very little; the manganese content of the charge was never more than 5 per cent., its sulphur content was low, and an endeavour was made to maintain a neutral atmosphere in the furnace, all of which may have tended to keep down the loss in manganese. As regards sulphur, if the oil fuel is free of, or low in, this impurity, its percentage will not increase in the furnace as it will in a cupola using coke. Material of the same chemical composition gave cast-iron containing 0.092 per cent. sulphur in the furnace, and 0.14 per cent. in the cupola. The phosphorus content, of course, remains unchanged. Nor was there any great change perceptible in the total carbon content, which may be due partly to the high silicon content, which preserved the carbon, and partly to the purposeful shortage in the air supply producing soot.

Electric Steel and Forging Industry.

In a Paper presented at the recent annual meeting of the American Drop Forge Association Mr. Arthur V. Farr, sales manager of the Hess Steel Corporation, Baltimore, U.S.A., gave a schedule of a 6-ton heat as an illustration of the furnace reactions that take place, showing the various stages in the making of a heat of electric steel. The steel to be made was a high carbon chrome steel used for balls for bearings. According to the author, electric steel, because of its density, should be cast in inverted moulds with refractory hot tops, to prevent any possibility of piping in the body of the ingot. There is a growing tendency for forging companies to have well-fitted-up laboratories for the examination of the structure of the steel that they are using. This is distinctly a forward step, and points the way to accurate heat treatments and more satisfactory results. The author says he has not made any attempt to compare the relative merits of open-hearth and electric steel. Results in service, day in and day out, have thoroughly established the superiority of the latter. One forgeman expressed his experience tersely, as follows:—"We can get physical properties much easier with electric steel."

The Schedule is reproduced herewith:—

11.50 a.m.—Material charged:—Boiler plate, 5,980 lbs.; stampings, 5,991 lbs.; limestone, 700 lbs.

12.20 p.m.—Completed charging, and current switched on.

3.20 p.m.—Charge melted down. Preliminary analysis under black slag in per cents.:—0.06 C.; 0.014 Si.; 0.032 S.; 0.009 P.; 0.08 Mn. Note the practical elimination of phosphorus.

3.40 p.m.—The oxidising (black) slag is now poured and skimmed off as clean as possible to prevent rephosphorising and to permit the addition of carburising materials in the form of powdered coke, ground electrodes or other forms of pure carbon.

The deoxidising slag is now formed by additions

of lime, coke and fluorspar (and for some analysis ferro-silicon). The slag changes from black to white as the metallic oxides are reduced by the additions and the reduced metals return to the bath. After the slag becomes white, some time is necessary for the absorption of the sulphur in the bath by the slag. The action of desulphurisation in the electric furnace is as follows:—After the bath is deoxidised, as described, the slag acts on the metallic sulphides, eliminating them by forming calcium sulphide, which is taken up by the slag, as shown by the following equations:—

$$FeS + C + CaO = CaS + Fe + CO$$

$$MnS + C + CaO = CaS + Mn + CO$$

$$2\ FeS + 2\ CaO + Si = 2\ Fe + 2\ CaS + SiO_2$$

The white slag disintegrates to a powder when exposed to the atmosphere and has a pronounced odour of acetylene when wet. Further additions of recarburising material are made as needed to meet the analysis. The further reactions are shown by the following:—

3.40 p.m.—Recarburising material added:—130 lbs. ground electrodes and 25 lbs. ferro-manganese. Analysis:—0.76 C.; 0.011 Si.; 0.030 S.; 0.008 P.; 0.26 Mn. To form a white slag there was added:—225 lbs. lime, 75 lbs. powdered coke, and 55 lbs. fluorspar.

4.50 p.m.—Analysis:—0.75 C.; 0.014 Si.; 0.012 S.; 0.008 P.; 0.28 Mn. Note the reduction of the sulphur content.

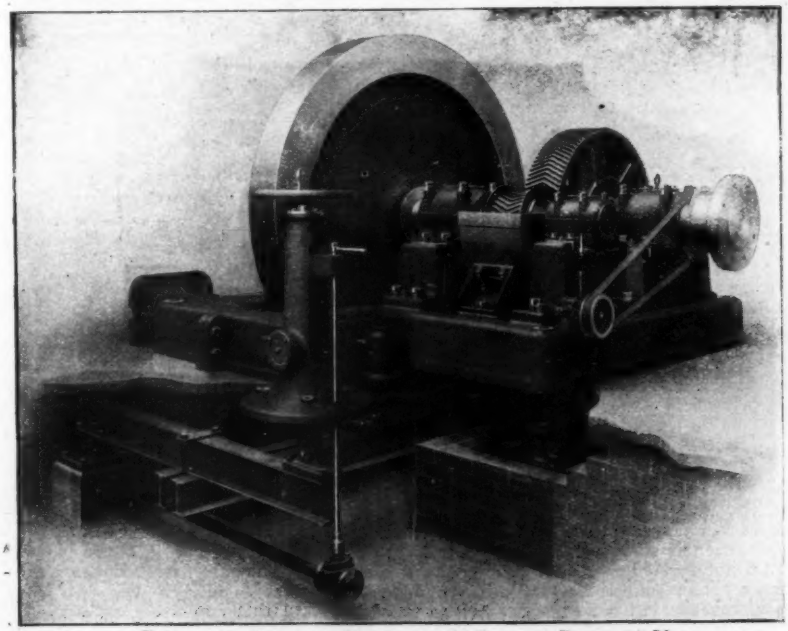
During the white slag period, the following alloying additions were made:—500 lbs. pig-iron, 80 lbs. ferro-silicon, 9 lbs. ferro-manganese, 146 lbs. ferro-chrome. The furnace is now tipped forward and the charge poured into the ladle.

5.40 p.m.—Heat poured. Analysis:—0.97 C.; 0.25 Si.; 0.014 S.; 0.013 P.; 0.33 Mn.; 0.70 Cr. Ingot weight poured, 94 per cent.; scull, 2.7 per cent.; loss, 3.3 per cent.

Total current consumption for the heat, 4,700 kw.-hours, or 710 kw.-hours per ton.

Reduction Gear for Electrically-Driven Piercing Mill with High-Speed Cast-Steel Flywheel.

We illustrate herewith a reduction gear built by Messrs. David Brown & Sons (Huddersfield), Limited, which is installed in connection with a piercing mill, in which the power required is considerably in excess of the output of the motor for a short period. The normal h.p. of the motor is 400, whilst for a few seconds of time the power required on the piercing-mill shaft is approximately 800 h.p. The motor speed being 730 r.p.m., and the mill shaft 192 r.p.m., the reduction in speed is obtained by a DBS 28-in. standard single-reduction gear, consisting of machine-cut steel double-helical wheels, with teeth of the continuous type, generated by Messrs. Brown's special process, mounted on forged steel shafts running in self-oiled pedestal bearings lined with anti-friction metal. The latter are of extra heavy design to ensure rigidity, and are mounted on a heavy cast-iron bedplate, with flanges on one side to couple to the motor bed. The gears are enclosed in a case constructed of strong steel plates riveted together so as to form an oil tank, and the teeth are positively lubricated by means of an oil pump which forces the lubricant through spray nozzles direct to the point of contact.



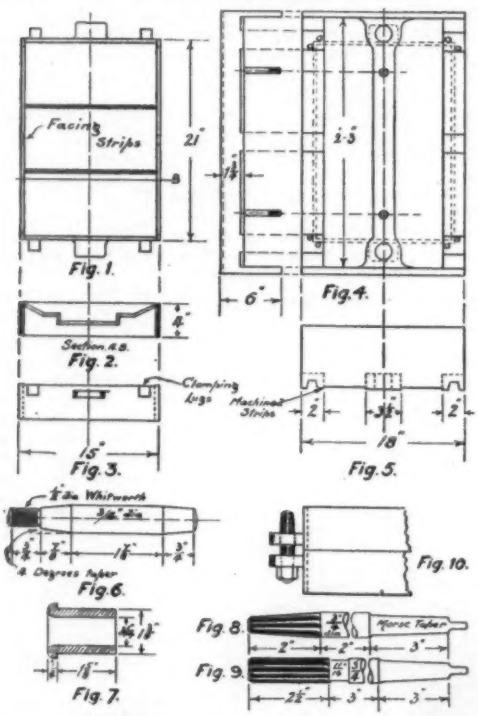
Reduction Gear for Electrically-Driven Piercing Mill.

On the end of the pinion shaft is keyed a cast-steel flywheel weighing approximately five tons, and having a peripheral speed of 18,000 ft. per minute, which is arranged to give out during the full-load period the excess power required above the output of the motor, with a speed drop during this period of 10 per cent. The flywheel boss is made in the form of a half coupling to which the motor coupling is rigidly bolted, so that half the weight of the wheel is carried on the motor bearing and half on the adjoining pinion bearing. The flywheel is machined all over, and carefully balanced and polished so as to reduce windage. As the wheel runs for about 1¼ hours after shutting off the current, a water-cooled brake is fitted to its rim to enable it to be brought to a standstill within a short period if required. The control valve for the water supply is operated from the pillar carrying the hand wheel, and the brake is capable of bringing the flywheel and gear to rest in three minutes. The brake shoe is lined with Ferodo fibre.

Drilling and Pinning Box Parts.

By F. R. Parsons.

Two, three, or four-part boxes require careful and exact matching and pinning, for upon this depends very largely the resultant condition of the castings. Not infrequently friction arises between the respective managers of the foundry and the fitting shop when the former lays it down to the latter with unmistakable clearness that the very best which can be done towards ensuring an easy yet shakeless fit of the two halves of a box is not a bit too good for a foundry; and that even if micrometer methods are suggested as a means to the provision of a perfect-fitting box, its very importance, from the foundryman's point of view, renders the answering sneers and jibes ill-timed and unnecessary.

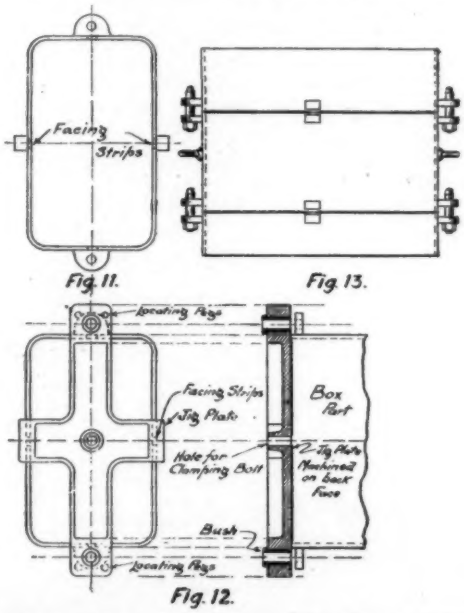


At one time, however, the writer did not subscribe to these foundry foreman views, contending rather that such exactitude, even if obtained when fitting up new boxes, could not for long be maintained under the peculiarly rough conditions met with on the foundry floor, together with the untender, unsympathetic treatment accorded such equipment at the hands of the moulders. He has, however, seen fit somewhat to modify these views, purely personal interest in a particular job which affected the output of his own department, and which hinged upon foundry excellence, being primarily responsible for this change of opinion. And now the aforesaid foundry manager doesn't let him forget it.

It is held by some of the old school that to ensure the necessary degree of accuracy and means for interchangeability in box parts sufficiently satisfactory results can be obtained by first fitting carefully a pair of two-part boxes, drilling and pinning them, then, removing the pins, using the respective parts as drilling jigs or templates wherewith to drill and pin the remainder; and that by such a method it is quite possible to ensure a continuity of accurate results and interchangeable conditions.

The present writer has tried this method in an attempt to save the cost of jig-making, but he cannot say that he is much enamoured of it—neither has been the foundry foreman! He, the writer, is therefore now firmly persuaded that there is but one way of ensuring accuracy and interchangeability, and that is by the use of a jig. Moreover, such a method certainly permits box fitting and pinning to be done by less skilled and less expensive labour, and in much less time.

The jig, together with the method of using it, about to be described, was designed specifically to



deal with plain two-part boxes of medium size for light floor work, and is shown by Fig. 1; a sectional view through A B being seen at Fig. 2, while Fig. 3 shows an end view; the overall dimensions of the box being given. The jig plate appears in plan and side elevation at Fig. 4, in end view at Fig. 5.

Now let us look into the method of drilling and pinning. As the box parts come into the fitting shop from the foundry they are first taken in hand by a fitter, who proceeds to level the abutting faces of the boxes, to this end using a cast-iron machined plate about 3 ft. 6 in. square, the necessary correction being effected from the four raised points shown on the edge of the box in Fig. 1; these being chipped and filed accordingly in order to ensure an equal bearing without rock at all four points. This done, the box parts are then ready for attachment to the jig for drilling.

The jig plate is a cast-iron hollow frame provided at each end with a deep bearing web, these requiring to be slightly in excess of the box depth, and must be machined true on their edges, so that when the plate is turned over on to the drilling

machine table it shall have a true bearing. The thickened-up longitudinal bars are of channel section for lightness and strength, while the middle bar is widened at the two ends in order to take the holes for the drill bushes. Four facing pieces, one at each corner of the jig plate, require to be machined true with the bearing webs; these are for the purpose of supporting the box parts at those points trued up from the levelling table.

The box is laid in position within the jig, as shown dotted, and locating pegs provided at the corners, the position of the two bush holes being found after determining suitable centres in the box lugs. The box part is dropped into position and held in place by means of a wrought-iron strap bridging the box, and held firmly thereto by one or more studs and nuts; these being shown in the side elevation (Fig. 4). The jig plate and box part is then turned over on the bearing webs and put upon the machine table; the box being, of course, suspended to the under side of the jig plate.

The first operation consists of drilling the two lugs to receive the pin; the latter shown dimensioned at Fig. 6. It will be necessary to provide three hardened steel bushes, as in Fig. 7, alike in every respect excepting the bore, this being respectively $\frac{3}{8}$ in., 23-32 in., and $\frac{3}{4}$ in. + 0.005 in. We start by inserting the $\frac{3}{8}$-in. bush in the hole provided in the jig plate, and then drilling through each lug a $\frac{3}{8}$-in. diameter hole. The two holes thus drilled we substitute for the drill the taper reamer indicated at Fig. 8, which is made to suit exactly the tapered end of the pin, employing the use of the $\frac{3}{8}$-in bore bush to serve as a guide for the reamer. This box part is now removed from the jig plate and the other half inserted, the 23-32-in. bore bush used, and a drill this size run through each lug; after which the parallel reamer, shown by Fig. 9, and which is two or three thousandths larger in diameter than the parallel portion of the pin, is employed to give the necessary pin clearance to the hole.

The pins inserted in one part of the box, the other half is matched, as in Fig. 10, and it should then fit without sticking or hanging, and without any appreciable shake.

An alternative example of jig design is given in Fig. 11, this being designed by the writer to fit up and pin a number of three-part boxes of the type shown in Figs. 12 and 13. As will be seen, the jig plate is a channel section cross of cast iron, made to strap in position across the face of the box part, and levelled from the facing strips shown on the box at Fig. 12. Two forms of locating means can be adopted—either that shown effecting lug location, or by means of location pegs so disposed as to operate from the inside of the box. The method of drilling and pinning was exactly the same as in the preceding example.

Some Developments in Industry During the War.

Mr. F. Kellaway, M.P., Parliamentary and Financial Secretary of the Ministry of Munitions, delivered an address on this subject at a meeting of the Industrial Reconstruction Council at the Hotel Metropole, London, on Friday last, Sir Wilfred Stokes, K.B.E., presiding.

Mr. Kellaway said he intended to confine his remarks to certain developments that had taken place in industry during the war. The war had revealed with pitiless accuracy the defects in our industrial equipment. Many of these defects had already been overcome, and the United Kingdom was now first in almost every sphere of industrial effort.

The quantity of ferro-chrome produced in the United Kingdom prior to the war was practically negligible, but a plant had now been established at Newcastle sufficient to meet our requirements for many years to come, the power being obtained from waste gases from coke ovens, and the industry would compete successfully with the cheap water power of Scandinavia.

Australia had practically unlimited deposits of zinc ore. Germany obtained control of these, and imported from Australia a large portion of her supplies. The zinc concentrates now flowed from Australia to this country, and zinc smelters' plants were doubled, and in some cases trebled. The shipping position from Australia became so serious that all shipments of zinc ore from that quarter had to cease, but that difficulty should soon disappear, and the home production of spelter should reach 140,000 tons per annum, as against 32,000 tons before the war. The production of zinc oxides had also been encouraged, and on a war basis we were self-supporting.

The machine-tool industry was one that presented us with what looked like an almost insoluble problem at the beginning of the war, but the position had been met with astonishing success, having regard to the difficulties which the manufacturers had experienced in obtaining the necessary skilled labour. While we had never had as many machine tools as we could have utilised, our munitions supply had never been jeopardised thereby. The output in this country prior to the war was valued at £4,000,000 per annum. For 1917 the output was increased to £6,500,000, based on pre-war prices, or £10,000,000 at war prices. Specialisation had been so fully developed that it was highly probable the manufacturers would continue to specialise. Our output showed an increase of 66 per cent. in 1917 over pre-war production, compared with the German increase of 23 per cent.

With regard to engineering methods, great advances had been made in the improvement of machinery, in accuracy of work, and in efficiency, which was the result of the necessity of organising for the production of interchangeable repetition work. In many shops the apparently fine limits which war work required caused considerable dismay at the start, many old machines were found to be unsuitable for giving the accuracy which interchangeability necessitated, and fresh machines had been put down which were in every way more efficient. Increased efficiency of production had been secured by the increased use of milling machines, improvements in screw threads, development in drop stampings, and increased use and delicacy of gauges and die castings. All this had led to a realisation of the importance of having an up-to-date tool room, where the tools were made by men expert in that work, and the importance had also been realised of the use of "gigs." A great advance had also been made in shop transport. In addition to mechanical conveyors, there were also in universal use electric trucks, with or without trailers, and platforms or skids on runners which could be lifted on low trucks on wheels and run to the desired position and deposited with their loads of work exactly where they were required.

As an instance of the importance of scientific knowledge as an aid to production, Mr. Kellaway mentioned the study which had been made of alloy steel giving high strengths which had allowed of its employment for aeronautical purposes, lightening the aeroplanes and allowing of better performance. The same held good to a certain extent of the light alloys employed for aircraft work. None of the other advances made in this war could be compared with that made on aeronautical work. Aircraft engines had not only become more powerful, but their weight per h.p. had decreased to about one-third of what it was at the beginning of the war, and it was not too much to hope that before long the weight of the engine would be the same as the h.p. in lbs.

Urgent Ship Repairs Involving Castings.

By "Ben Shaw."

Owing to the present congested condition of our principal ship-repairing harbours it often occurs that a ship will put into a small port through some breakdown in her engine room. Many of these small ports do not possess works capable of repairing the damage in a time consistent with the demand which is at present so essential; hence larger firms, connected with other ports, are frequently invited to undertake the work in order to obtain satisfactory results with the utmost dispatch.

When the repairs necessitate a casting, a considerable amount of valuable time is often sacrificed before a suitable drawing is provided to further the work through the departments. It

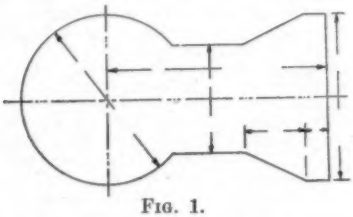


FIG. 1.

is not uncommon for a drawing, in the recognised sense, to be neglected altogether, the workmen simply relying upon sketches, correctly dimensioned, obtained by some responsible person who is sent to the ship for the necessary particulars.

In the larger kind of repairs it is usual to send a draughtsman who undertakes the responsibility of providing all the necessary information respecting the required work to the drawing office, so that suitable drawings may be prepared, the actual work being "held up" until these drawings are forwarded to the departments required to deal with it. Even in peace times this method seems inefficient, as much valuable time is lost. When damage has been caused to the shell of the ship temporary repairs are effected, and it is towed, or makes the journey under its own steam, to a shipping port with the necessary appliances for doing the work more quickly and more economically. When, however, the breakdown consists of some main part of the engine, the repairs can be carried out satisfactorily without bringing the vessel to the port where the work is to be done.

Some time ago an instance of this kind happened where a vessel suffered breakdotwn by the bursting of the high-pressure cylinder, and was taken to the nearest convenient port. The local firms were unable to deal with the necessary repairs expeditiously; hence a larger firm, some distance away, undertook the work. In such circumstances a drawing is required to be supplied to the pattern-making department, therefore it is necessary that a draughtsman be sent to obtain all particulars; but, seeing that the principal part of the repairs involves a large casting, a responsible patternmaker should also be sent who is capable of determining the method of constructing a pattern which will fill all the requirements of the foundry. His stay on the ship need only be of very short duration, as, once he has determitned the general formation of the cylinder, he will proceed to take a few dimensions, sufficient to commence with the work in the pattern shop and continue until the drawing is forthcoming. He can determine whether a lagged-up pattern will be necessary, or whether, by having parts swept up in loam and other parts made in wood, quicker results will be obtained in the foundry. In this instance it is better to lag up the full pattern. Then the dimensions the patternmaker would need for the block can be readily obtained. A sketch similar to Fig. 1, showing a plan formation with the requisite dimensions filled in, together with the height over the flanges, but less the facings, will suffice. With these particulars the work can be commenced and the pattern body almost completed before the department receives the blue print.

Whatever method may be adopted, there is much that can be done to expedite the job before the drawing is supplied. An instance of other work in connection with our ships, which can be dealt with expeditiously and in a more direct manner, is the propeller. In connection with the replacement of this essential part of the mechanism the services of the draughtsman can be dispensed with if the requisite casting is supplied by one of the foundries which make a speciality of propellers. Even if a quotation is necessary, the foundry firm will usually send a patternmaker to inspect what is left of the old casting, who will determine its general characteristics and its approximate weight. The particulars can be given by telephone, and probably in less than half an hour a decision given whether the job has been secured, in which case the patternmaker will proceed to take all requisite dimensions. To the average patternmaker, sent on such a job, this would present a very real difficulty, but not so to the foundry patternmaker who has gradually become experienced in this peculiar class of work. Perhaps a brief description of the procedure would be

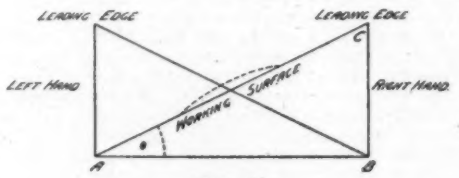


FIG. 2.

helpful, not only to patternmakers, but also to draughtsmen who may be called upon to secure the necessary particulars.

We will suppose the propeller required is to be cast solid and has four blades, as is usually the case for cargo steamers. The damaged one may only have two whole blades left, and it is from these that the pitch is obtained, together with other important details. The remains of the old propeller may be in the dock bottom, where it has been laid after removal from the tail-end of the shaft, but for greater convenience it is frequently lifted to the dock side, where it should be laid as level as possible, with the working face upwards.

The first consideration is to determine whether

the propeller is left- or right-handed. The leading edge of the blade is always nearest to the ship, *i.e.*, to the largest bore diameter of the boss; then a right-handed propeller will be determined by a right-angled triangle, having its vertical line on the right-hand side and the leading edge at the top, as shown by Fig. 2, the hypotenuse representing the working face of the blade. The reverse will apply to a left-handed propeller.

To obtain the pitch it is necessary to mark on each of the blades a number of concentric arcs at convenient distances from the centre of the propeller boss. At least two blades should be prepared in this way, and the pitch of each found, so that should any difference occur the mean may be taken. To mark these as accurately as possible it is useful to secure a piece of wood, cut to a diameter similar to that of the small bore in the boss; by securing this to a parallel straight edge, sufficiently long to take the diameter of the propeller, and, passing along the centre, it can be revolved and the correct centre maintained. The distances at which the arcs are required are set off on the straight edge, commencing from the centre of the small bore and working outwards to the tips of the blades. These distances are transferred to the blades by means of a square and a light straight lathe, revolving the straight edge so as to obtain the arcs on the full width of the blades. Once these lines are on, the pitch can be determined, and for this purpose an instrument termed a pitchometer is most useful. This instrument is provided with an adjustable level attached to a movable arm, the whole attached to a brass plate marked off in degrees, in the form of a protractor. With the movable arm closed—*i.e.*, registering no degrees on the protractor—the level is adjusted by setting the instrument on the machined surface of the boss and approximately at right angles to a centre line on the blades about to be tried. The instrument is then set across each concentric arc in turn, extending the legs of the pitchometer to take the width of the blade,

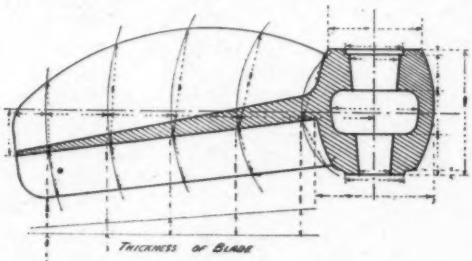


FIG. 3.

and moving the arm upon which the level is fixed until it shows it to be out of winding with the surface of the boss. The reading is then taken from the graduated quadrant. The angle found will determine the relation between the surface of the blade at a given distance from the centre and the surface of the boss, and as the surface of the boss is at right angles to the horizontal centre of the shaft upon which the propeller is fixed, the pitch at that position can readily be calculated; the same procedure being adopted for each of the positions on the blade determined by the arcs. In the more expensive types of pitchometers all the information can be obtained on the instrument, one of which is represented by a sketch; these have the pitches tabulated for various degrees of angle at given diameters, so that, having found the angle in the manner shown on any of these arcs, by referring to the table, the correct pitch can be readily determined. When a less expensive pitchometer is used, it may be necessary to calculate the pitch from the particulars obtained. This can be done by multiplying the circumference of the position tested by the tangent of the angle—thus, in Fig. 2, A B × tan. θ = C B. In obtaining results at a number of places, their distances gradually increasing from the centre of the boss, it will be determined whether the propeller required is a true screw or one having a varying pitch, and by testing

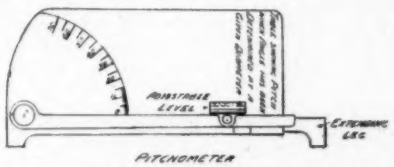


FIG. 4.

another blade in a similar manner the results can be compared. It is necessary to find out how much the blade is "set back," if any; hence a centre line should be marked along the blade. To do this, obtain a straight surface about the centre of the blade and as near to a line perpendicular with the centre of the shaft as the surface of the blade will allow; this can be considered the centre of the blade, and can be marked as such. Then, by means of the straight edge, measure the distance from the face of the boss to the junction of this line with the boss and also at the tip of the blade, and from these the "set back" is determined. Make a note of the sizes of the blade, measured from the centre and on the concentric arcs to the outside edge. The sketch shown in Fig. 3 illustrates the dimensions required and the essential particulars. No drawing need be prepared, as a commencement can be made with the mould for such a propeller within an hour of the pattern-maker's return.

THE ANGLO-MEXICAN PETROLEUM COMPANY have issued a striking and artistic calendar reproducing in facsimile a chalk drawing of the Mexican Eagle Oil Company's famous gusher, Potrero No. 4. The picture shows the well, flowing uncontrolled, immediately after it was brought in, and is of unusual interest in view of the news just received that this prolific well has ceased to yield. This will not, of course, diminish the company's output, as there are numerous other wells which have been brought in but are shut down for lack of transport. Tank steamer facilities really control the output from Mexico, which should be considerably augmented by the service of the giant tank steamers, carrying 18,000 tons of oil, of the A.M.P. Company, the first of which, the "San Florentino," was recently launched at Wallsend. The lower part of the calendar has a picture of a British squadron under full steam, and an appropriate quotation from Lord Fisher on the value of an oil-fired Fleet effectively links up the two pictures, and incidentally reminds one of the valuable services rendered to the country during the war by the Anglo-Mexican Petroleum Company, Limited, with its great fleet of tank steamers and vast supplies of Mexican fuel oil for the navy.

C

Recent Development of Electric Steel Furnace.*

By F. J. Moffett, B.A., M.I.E.E.

In a steam-driven station supplying electricity the efficiency of the best boilers does not at present exceed 75 per cent., which means that 25 per cent. of the energy of the coal is lost at this stage. The steam generated in the boiler is then passed into the turbines, the efficiency of which does not often reach 25 per cent.; there is, therefore, a loss here of 75 per cent. In the generators the efficiency may be 95 per cent. and the efficiency of transformation and transmission may be taken at 85 per cent. The overall efficiency from the coal to the units of electricity in the furnace will therefore be roughly 15 per cent. In spite, however, of this low efficiency from fuel to units at furnace, the electric furnace can, in certain directions, show better results than the combustion furnace. Undoubtedly the chief reason lies in the fact that the electric furnace itself is so much higher in efficiency than the combustion furnace. Dr. Stansfield has carefully examined this question. and the figures quoted here are due to him. The efficiency of any furnace—combustion or electric—is the ratio between the heat usefully employed in the furnace to the heat value of the fuel used or the electric energy supplied. Take first the crucible furnace for melting steel:—

$$\text{Efficiency} = \frac{\text{Weight of steel melted} \times \text{heat to melt 1 lb. steel.}}{\text{Weight of coke} \times \text{heat furnished by 1 lb. coke.}}$$

$$= \frac{100 \text{ lbs.} \times 540 \text{ B.T.U.}}{150 \text{ lbs.} \times 13{,}000 \text{ B.T.U.}} = 0.028.$$

The efficiency of this furnace is therefore 2.8 per cent. Now take the electric steel furnace. The charge consisted of:—Steel scrap, 5,733 lbs.; iron ore, 430 lbs.; lime, 346 lbs.; total, 6,509 lbs. It required 1,680 kw.-hours to melt this charge, but in addition some heat was furnished by the reaction between the steel scrap and the iron ore. Hence the heat supplied to the furnace was 1,680 kw. hours of electric energy = 5,700,000 B.T.U.; reaction between steel scrap and iron ore = 43,000 B.T.U.; hence total = 5,743,000 B.T.U. The heat utilised in the furnace was:—To melt 5,660 lbs. soft steel = 3,485,000 B.T.U.; to melt 850 lbs. basic slag = 920,000 B.T.U.; hence total 4,405,000 B.T.U. The efficiency of the electric furnace is therefore 77 per cent. roughly, as against the efficiency of the crucible steel furnace of 2.8 per cent.

The following figures give the approximate efficiencies of furnaces used for melting metals:—Crucible steel furnace, 2—3 per cent.; reverberatory furnaces, 10—15 per cent.; regenerative open-hearth, 20—30 per cent.; foundry cupolas, 30—50 per cent.; electric steel furnaces, 60—85 per cent.

Apart from the high efficiency of the electric furnace, it possesses other advantages over the combustion furnace for special purposes such as refining steel. One of the most important of these is the possibility of obtaining high temperatures. The temperature of the volatilisation point of carbon is in the neighbourhood of 3,500 deg. C., so that it is easy to obtain temperatures of 2,000 deg. C. and upwards. With a combustion furnace the temperature limit is, of course, much lower.

Speaking generally, low temperature heating is done more economically by combustion, whereas for the higher temperatures about 1,500 deg. C. it is cheaper to use electricity. The cheapest way to reach temperatures above 1,500 deg. C. is to combine the two systems, *i.e.*, to use combustion heat for melting and electric heat for refining. This is being done to an increasing extent in many steel works at the present time, crucible or open-hearth furnaces being used for melting and electric furnaces for finishing.

Another advantage of the electric furnace is the ability to obtain a neutral or a reducing atmosphere in the furnace, as it is possible to seal it up and render it more or less air-tight. The proportion of oxygen can be reduced at will, and the atmosphere becomes in consequence either simply neutral or even capable of taking up oxygen from the charge that is deoxidising or reducing. The possibility of rendering the electric furnace air-tight has the further advantage that the heat losses are greatly reduced, and it is largely due to this fact that the efficiency is so high.

Amongst other advantages may be enumerated: Rapidity of heating; absence of impurities introduced by the combustion of fuel such as sulphur; ease, accuracy, and reliability of control and regulation; greater uniformity of the product; and greater output for a given size of furnace.

The author next described the different types of electric furnaces, and then the method of operation of the steel furnace. After the furnace has been fettled from the previous charge, the cold scrap is thrown into the hearth. When charging is completed the current is switched on and kept as constant as possible, either by hand or by an automatic regulator. Melting soon begins, and during this period the flux is added, consisting of a mixture of lime, fluorspar, sand, and either iron ore or banner scale. This flux floats on the top of the molten metal, and the chemical actions of refining take place. The carbon in the scrap is oxidised by the oxygen in the iron oxide of the flux and is given off as carbon-monoxide. This rising through the bath gives the appearance of boiling, and has the effect of thoroughly mixing the flux and the metal. The silicon and the manganese are oxidised, and these oxides dissolve in the flux. The phosphorus also is oxidised, and forms, with the lime, a phosphate which also enters into the slag. A portion of the sulphur oxidises and passes away in the gaseous state. When sufficient time has been allowed for these reactions to take place, the current is switched off, and the slag run off by tilting the furnace, the surface of the metal being carefully cleared. An addition of carbon is then made to provide the necessary carbon in the steel, and a second flux is thrown in, this also consisting of lime, sand and fluorspar. During the subsequent refining only about half the voltage is required.

* Abstract of Paper read before the Staffordshire Iron and Steel Institute on November 9.

The phosphorus has already been removed, but the bulk of the sulphur and a certain amount of iron oxide still remains. This iron oxide is solved in the second flux, and is removed by the addition of finely-powdered anthracite dust, which reduces the iron oxide, and at the same time forms a reducing atmosphere in the furnace. The sulphur is also gradually dissolved in the flux, and at the end of the second purification the metal is ready for pouring.

The most important field for the electric steel furnace is the production of a uniformly good quality of steel from cheap scrap material such as turnings and crop ends, which can be fed into the furnace without any preparation. In the case of alloy steels, it is possible to make a steel of uniform composition since the amount of alloy to be added can be calculated exactly from the analysis of the steel in the furnace. Steels containing nickel, chromium, vanadium, etc., can be melted without any loss of these elements. Steel castings can be produced which are dead mild and do not require any subsequent annealing. The properties of ordinary electric cast steel are: —Tensile strength, 35 tons per sq. in.; yield point, 25 tons; and elongation, 30 per cent. By the addition of elements such as nickel, a much higher tensile strength can be obtained. The electric steel casting is therefore capable of taking the place of a steel forging for many purposes. Owing to the high temperature at which the charge can be poured, the steel is very fluid and allows of castings of intricate shape being made without difficulty. Electric steel castings will doubtless in the near future take the place of malleable iron castings, which have to be treated by a tedious and expensive annealing process.

At the end of the year 1917 the furnaces installed were as follows:—Héroult, 46 varying from 1½ to 10 tons; Greaves-Etchell, 31 varying from ½ to 12½ tons; Electro-metals, 27 varying from 1½ to 10 tons; Rennerfelt, 8 varying from ¾ to 2½ tons; Stobie, 6 varying from 5 to 15 tons; other makes, 22. It is of interest to mention that of the above 140 furnaces nearly one-half are in the Sheffield and Rotherham district. Further, it is evident that the arc type of furnace has established its superiority from a commercial point of view. The induction furnace is now very rarely adopted in this country for steel refining.

The following is a list of standard sizes of furnaces with the transformer capacity and the approximate units per ton of finished steel:—

Size.	Transformer capacity.	Units per ton.
25 cwt.	300 kw.	850
2½ tons	500 ,,	800
5 ,,	800 ,,	750

It is evident that the units per ton are less in the larger furnaces; this decrease does not go on indefinitely; when the capacity of 15 tons is reached, the units per ton appear to reach their minimum value. Sir Robert Hadfield, in a recent account of the fuel and electric power consumption in his works at Sheffield, tated that in 1917 the units per ton used for 31,850 tons of electric steel was 782.

The cost of electrical energy is the most important consideration in the operation of an electric furnace. When it is possible to use blast-furnace or coke-oven gases for the generation of electricity, the cost can be brought very low. If a by-product recovery plant is employed, gas can be produced cheaply and used for driving electric generators by gas engines. With the urgent need for economy in the use of fuel and the demand for the by-products derived from coal, it is probable that in the period following the war very much more attention will be devoted to this method of power production. Electric energy has proved to be so essential for the output of munitions of war of every description that there is no doubt but that the use of electricity will be enormously increased. The tendency will be for the cost per unit to diminish as the output increases. The supply of electricity to an electric furnace or furnaces can always be given at a lower rate than for most other purposes, owing to the good load factor. An electric furnace can be worked continuously through the 24 hours at a fairly uniform load. This is the condition which allows a generating station to generate at a minimum cost. We are therefore justified in looking forward to the possibility of obtaining in the near future electric energy for furnace work at a cost of something like 0.2d. per unit.

Pig-Iron Output in 1917.

According to Part III. of the Mines and Quarries Report recently issued, the output of pig-iron in Great Britain in 1917, and the quantities of coal and coke used in its manufacture, were as follows:—

County.	Pig-iron made.	Iron ore used, including cinder, etc.	Coal used.	Coke used.
ENGLAND.	Tons.	Tons.	Tons.	Tons.
Cumberland ..	782,448	1,449,715	21,350	1,023,718
Derby and Nottingham	543,534	1,680,428	431,834	619,753
Durham	1,134,491	2,598,703	82,569	1,409,153
Lancaster and Flint	739,148	1,458,256	4,636	1,037,185
Leicester and Lincoln	649,191	2,338,910	45,747	1 096,731
Monmouth ..	318,994	664,698	19,093	406,526
Northampton ..	300,350	893,771	63,406	455,824
Salop and Stafford, North	368,068	1,008,652	250,3[illegible]	356,571
Stafford, South ..	401,032	904,777	108,[illegible]	482,965
Worcester ..	32,443	112,027	17,2[illegible]	33,077
York, North Riding	2,095,619	5,547,398	192 507	2,576,575
York, West Riding	307,292	915,824	47,921	436,279
Total	7,672 610	19,573,159	1,285,640	9,934,357
WALES.				
Denbigh	48,992	137,655	4,290	57,717
Glamorgan ..	459,578	938,283	8,554	493,165
Total	508,570	1,075,938	12,844	550,882
SCOTLAND.				
Ayr	336,725	717,714	510,348	113,754
Lanark and Stirling	820,199	1,534,903	1,007,486	362,741
Total	1,156,924	2,252,617	1,517 834	476,495
Total in 1917 ..	9,338,104	22,901,714	2,816,318	10,961,734
Total in 1916 ..	8,919,469	21,505,556	2,612,543	10,300,888

The value of the 9,338,104 tons of pig-iron obtained from British and foreign ores in 1917 would be, according to the average export value for the year, £86,192,279, of which 4,688,063 tons, valued at £43,271,614, were due to pig-iron from British ore. Of the 9,338,104 tons of pig-iron obtained, 733,943 tons were exported, leaving 8,604,161 tons available for home consumption. The average prices per ton of pig-iron during 1917 were:—Cleveland No. 3, quarterly ascertained prices £4 17s. 4d., quoted prices £5 1s. 2d.; and of all kinds of pig-iron exported £9 4s. 7d. The return of the Iron and Steel and Allied Trades Federation gave the output of pig-iron at 9.420,254 tons in 1917, so that Mr. Lloyd's figures are about 82,000 tons in excess of the Home Office figures.

British Foundrymen's Association.

SHEFFIELD BRANCH.

Deformation of Castings.

At the meeting of the Sheffield Branch of the Association on November 22 Mr. Tom Brown, of Sheffield, read the Paper on "Deformation of Steel Castings" which was read at the Annual Conference of the Association held in Sheffield in June last. This he illustrated with lantern slides. In introducing his Paper, Mr. Brown regretted the want of interest shown by moulders in their work. Their thoughts always seemed very far removed from the job they had in hand. He sometimes wondered whether they gave a moment's thought to the reason why their foreman should tell them to do a job in a certain way. Did they, when they saw a defective casting, ever ask themselves the cause of the defect or how it could have been avoided? How often did a moulder when given a job ask himself, "What is the quickest time in which I can get it done, or how can it be done with the least possible waste of composition and energy?" He very much feared the moulder gave no thought to such questions; but that condition of things must be altered; the moulder of the future must think of the work he was engaged on. The sooner he began to realise that his trade was not only a skilled one, but an art, and the sooner he gave more study to his work, the sooner the trade would be elevated to a pinnacle which would be second to no trade or craft in the country. He appealed to moulders to give more study to their work, and the sooner they did so the sooner would the conditions in which they worked be improved. Mr. Brown then read his Paper, which appeared in our issue of August last.

Mr. Watson said he was very much interested in Mr. Brown's introductory remarks, and did not mind how much he rubbed it in with regard to the moulder, because, although he had seen some of the finest work turned out in Sheffield, yet there was something even for Sheffield moulders to learn. The mental attitude of the men with regard to the treatment that they got from the employers had to be altered. It was a very big problem, and he believed the solution was to be found in getting the men to understand that by increasing output they would be helping the industry and the country and their own earning capacity. They must get more money because it was necessary for them to be better fed, better housed, and to enjoy better working conditions than at present obtained in Sheffield. With regard to waster castings in steel foundries, there were so many conditions that helped to bring this about that one could not blame the moulder altogether—the way the metal was run, the way in which the risers were put in, the condition of the steel and the method of moulding all had something to do with it. In his opinion, it was necessary to get back to the apprentice; he had to be more the care of the employer than he had been in the past. They must teach the moulder that it was no disgrace for him to go into the fettling shop and have a look at the waste castings. He personally had never been able to persuade the moulder to go and look at the wasters; he said they had nothing to do with him. It was necessary to educate the boys to the idea that in going to look at a waster they were getting education in their trade that would be good for them. The education of apprentices should be to some extent carried on in the works. Take the case of a valve casting that had blown or was cracked; there should be someone competent to point out to the apprentice moulders the cause and the cure. Waster castings were a very serious problem, and he congratulated Mr. Brown upon his treatment of it. A great deal might, as he said, be done by distorting the pattern before starting to mould, but it was a thing that could be learned only by experience, and was not easy to figure out on paper. He joined issue with Mr. Brown on the fracture of the big castings. Mr. Brown believed in letting a casting go dead cold on the floor. He did not believe that was the correct treatment. Did Mr. Brown, when putting the casting into the annealing furnace and letting it cool off, heat it after it went in? (Mr. Brown: Yes.) He (Mr. Watson) considered that was the proper way to treat a big casting—not to bring it out when it would distort itself by its own weight, but when cool enough to handle it should be put into the annealing furnace and heated up to, say 1650 or 1700 Fahr., and then allowed to cool down in the furnace. There was great difficulty in heating up the whole of a big casting right to the inside if once allowed to go dead cold. He believed in many cases this caused the cracking—in heating up, not in the cooling. He had had experience of that in certain castings which had been allowed to go cold and put into the furnace, and had split in the furnace simply because the mass of metal was so great that the outside got hot too quickly in relation to the inside.

Mr. H. R. Philp agreed as to the risk of heating up a big casting unevenly. He thanked Mr. Brown for his excellent illustrations of what steel castings should be and the lessons to be derived therefrom.

Mr. F. Darley agreed that a good many castings "clinked" through being heated up. The risk might be reduced by reversing the furnace. He also deplored the little interest taken by the majority of moulders in their work. On other minor points he expressed disagreement with Mr. Brown.

Mr. Bradley thought there might be something to be said for the foreman sometimes asking the moulder how he would suggest going about a job, instead of simply telling the moulder his own ideas. That might excite more interest on the part of the moulder.

Mr. Hyde said he had been extremely interested to hear how a practical man like Mr. Brown tackled his difficulties. He and other subsequent speakers had shown that the experts were not united as to the causes of various troubles; if they were, the troubles would very soon disappear. He was greatly interested in the way in which Mr. Brown had analysed his castings and traced troubles to their sources as far as this was possible. There was no doubt that if troubles met with in the foundry were patiently traced to their origin in this fashion, that would be the first step towards arriving at a solution.

Engineer Captain Mark Rundle, R.N., D.S.O., thanked Mr. Brown for his thoughtful paper. There was evidently scope for a good deal of thought on this subject, and there was manifestly a good deal of diversity among the experts, and that fact constituted rather a difficulty when they came to teach the young moulder more about his business, because so much diversity would not lessen the difficulty of his education. The fact re-

mained, however, that the British moulder almost invariably turned out a good article, despite the many different ways he had of doing it. In regard to the situation between the employers and employed, there would no doubt have to be great improvement in this direction. Now that we had got rid of the Hun, there would be a new era of competition, in the course of which the best would come to the top, and unless we in this country applied our minds to the problems this and every other trade presented we might find ourselves outdistanced. There must be more co-operation and mutual recognition of difficulties. No doubt up to the present this country had achieved excellent results by mere experience, but in future this must be supplemented by a more intelligent understanding of problems, and such discussions as their Association afforded seemed to him to provide the needed opportunity.

The BRANCH PRESIDENT said one question had not been brought out: had the pouring temperature anything to do with fractures or deformation? He spoke, of course, more from the point of view of the non-ferrous founder, but when they had deformation or fracture they usually looked at once to the pouring temperature—that was their first concern. Of course, the metal with which they were concerned had a greater stretching property than steel and the conditions were entirely different; but, still, he imagined that even with steel the pouring temperature must have some effect.

MR. PHILPS believed it had, and cited experiences with three different castings all from one pot.

MR. DARLEY also instanced an experience in the casting of a spur wheel, made in halves; both moulds were exactly alike; the wheel was about 12 ft. diameter, and one half came out ¼ in. less than the other. He believed that temperature had a great deal to do with the results, both with respect to distortion and tendency of castings to "clink."

MR. WATSON remarked that the speaker had raised a very vital point. Unless the two halves of a wheel were cast together they could never be got alike, and that rather supported the Chairman's contention.

MR. BROWN, in replying to the discussion, said in reference to Mr. Watson's remarks, he (Mr. Brown) had alluded to the moulder looking at defective castings—not wasters. There might be many a defective casting that was not necessarily a waster. As for castings breaking in the furnace, he personally did not know of a case; he knew that they had been discovered cracked when cleaned, but whether the damage was done when in the furnace or after they came out he could not say—he feared it was after. His experience was also different to Mr. Watson's in regard to sending castings into the furnace when hot. He certainly believed in taking off the sand, as it could not be properly annealed otherwise; but if allowed to remain on the floor, the casting, in his opinion, would cool all over without distortion. He had proved it by experience. In regard to the President's inquiry as to temperature, his personal opinion was that it did not matter. The melting temperature of steel was always approximately at one point, and the solidification of steel also remained at one point, and there was no contraction took place prior to solidification. In regard to the three castings mentioned by Mr. Philps, he forgot that three men might have made the mould and so caused varying resistances in the three cases. It was the making of the mould and the resistances in it that might cause the differences alluded to. The same explanation might account for the President's varying results. Of course, this was merely his personal opinion, and he was open to correction. They knew as practical moulders that no two men could make two things identically alike.

SCOTTISH BRANCH.

The second meeting of the Session was held at Glasgow on November 16. Mr. R. R. McGowan, the Branch President, occupied the chair.

In his opening remarks the President referred to the close of the war and the part which foundrymen had taken in the production of war supplies during its course. The war had revealed the extent of Britain's resources; it had also revealed to foundrymen the importance of their industry. Foundrymen had every reason to feel proud of the part they had performed in supplying the materials of war, and by reason of this fact could rightfully claim a share in the general victory which had been achieved.

The President then introduced Mr. Thomas Bell, who read a Paper on "Moulding a Shrouded Impeller for a Centrifugal Pump, in Loam." The lecturer gave a very lucid description of the method adopted in producing the mould for this particular casting, which included a series of very intricate cores, some parts of which had to be made in a "dummy" or auxiliary mould, the principles of which were clearly shown. It was explained that the method of procedure, namely, to make the job in loam, was decided upon because of the fact that only one casting was required, and to make a pattern would have involved considerable cost.

The lecture, which was greatly appreciated, was illustrated by lantern slides. A discussion followed in which a large number of the members took part. The meeting terminated with a hearty vote of thanks to Mr. Bell for his lecture.

Semi-Steel.

The third meeting of the Scottish Branch of the British Foundrymen's Association was held at Glasgow on Saturday, December 7. Mr. R. R. McGowan, the Branch President, occupied the chair.

The CHAIRMAN introduced Mr. Matthew Riddell, the Junior Vice-President of the Association, who delivered a lecture entitled "Notes on Semi-Steel Practice."

MR. RIDDELL at the outset stated that a great impetus had been given to the production of semi-steel castings owing to the demands of the war. Prior to the war many firms had endeavoured to make semi-steel, but gave up the practice because of the difficulties which they had encountered. These troubles were caused by persons trying to solve a scientific problem without having a knowledge of the scientific principles associated therewith.

The demands of the war had made it imperative that nearly every foundry, and especially those in the light-casting trade, should produce semi-steel castings. This demand had forced many foundrymen to take a greater interest in the basic principles of their trade than they had done hitherto.

The chemical constituents of the metal, although very important in themselves, were only one of the many points which had to be considered in dealing

with this subject; the amount of material in the charge, the method of charging, the volume and pressure of the blast, the pouring temperature of the metal were all points which affected the successful working of semi-steel. The lecturer emphasised in particular the necessity of casting semi-steel at a high temperature, and stated that the reason for this was because of the fact that semi-steel solidified at a much higher temperature than ordinary grey iron. He considered this setting at a high temperature to be one of the causes for semi-steel having such a close grain. The range of fluidity of semi-steel was much less than ordinary foundry iron, and the casting of semi-steel at too low a temperature was the cause of many bad castings, the defects taking the form of blown holes and hard spots.

The lecturer exhibited four castings all cast from the same metal but at different temperatures. The casting poured first was perfect in every respect; the second was less perfect, showing signs of blow-holes; the third was less perfect than the second; and the fourth, which was cast last, was completely riddled with blow-holes. The lecturer explained that the cause of the defects in the castings was the lack of fluidity, the metal in its cooler condition retarding the escape of the gases, resulting in entrapped gases in the casting.

The increased strength of semi-steel was caused by the improved quality of the carbon, compared with the carbon in ordinary foundry iron. This he attributed to the carbon absorbed by the mild steel while in contact with the carburising influence of the charges inside the cupola. The state of the carbon had a distinct influence on the strength of a casting, and the importance of the chemical constituents in an iron was based principally on the influence which they had on the carbon, irons in which the graphitic carbon was high being weak.

Silicon up to a certain point had a softening influence on iron; in semi-steel the amount of silicon was reduced in proportion to the amount of mild steel introduced—therefore its softening influence was reduced accordingly. Phosphorus and manganese were also reduced, but sulphur was increased. There was a slight reduction in the total carbon and a decided increase in combined carbon.

The lecturer advocated small charges for semi-steel practice, and considered that a ratio of coke to iron of 1 to 10 would be quite ample to raise the metal to its proper temperature. An excessive proportion of coke did not always give a hotter iron; its action was sometimes in an opposite direction. Quick melting was hot melting, and hot melting was the secret of fluidity; therefore the lecturer favoured quick melting. A low well in the cupola gave the best results in semi-steel practice, as it prevented the mass of metal cooling in the well, because it had to be withdrawn before it reached the tuyeres. When metal was left in the well of the cupola its temperature was lowered, because of the fact that where no oxygen existed there could be no combustion.

A soft blast with an ample supply of air gave better results than a high cutting blast. Semi-steel was inclined to be hard, and as air at a high pressure increased the hardness of an iron, a high pressure should therefore be avoided. Another argument against a high-pressure blast was its oxidising effect on the steel in the charge. Steel was a pure material compared with cast iron, and therefore lacked the protective influence of silicon and the other chemical constituents which were contained in ordinary grey iron.

The lecture was illustrated with a number of lantern slides, including some micrographs showing the alteration which took place in the construction of a metal when a proportion of mild steel was introduced. Several examples were exhibited to prove that sufficient fluidity could be obtained when the metal was cast at the proper temperature.

A discussion followed, and a vote of thanks to the lecturer brought the proceedings to a close.

LANCASHIRE BRANCH.

A meeting was held at the Heginbottom Technical School, Ashton-under-Lyne, on Saturday, November 16, for the purpose of bringing the aims and objects of the Association before those engaged in local foundries. There were about 70 present.

Mr. W. H. Cook, of Heaton Chapel, presided, and in opening the proceedings said no branch of the engineering industry had been so neglected in regard to its scientific side as the foundry. Twenty years ago he was engineering master in that very school, and he estimated that roughly about 3,000 science students had been under his teaching. There was only one moulder amongst them. No other reason need be looked for to explain why the foundry was looked down upon by many people, whose views were summarised in the statement that it was a dirty job and there was no money in it. He entirely disagreed. There was more money in the foundry than in any other branch of the business if it was properly looked after and good castings were produced.

Mr. W. H. Meadowcroft, of Newton Heath, read a Paper on "The Objects and Aims of the British Foundrymen's Association.

Discussion.

Mr. J. Hogg, the Secretary of the Branch, said there were men in the Ashton district who had been able to overcome their difficulties because of the knowledge they gained by association with the other members. That was also his personal experience. The moulder was a highly skilled man, and his occupation ought to be made more attractive. The conditions of employment could be improved. He had not yet come across an employer who was not willing to do his part if it was made clear that the men desired an improvement and would help themselves. Then the better class of youths would be attracted.

Mr. Roe, President of the Branch, said he did not know why the moulders fought shy of the technical school. Perhaps one reason was that in other branches of industry a certain curriculum was provided, and all the studies were directed accordingly. The student had nothing to do but absorb information as it came along. In that respect the moulded was very unfortunately placed. To get information regarding his trade he had to wade through half a dozen curricula, and probably was unable to appreciate the value of the information he was getting until he got to the end. Most of them gave it up as a bad job.

The Chairman said pattern-makers worked to drawings, but in nine cases out of ten the man who made the drawing had not the slightest idea how the pattern-maker would make it. He had seen elaborate and beautiful drawings from Government offices which were sent to the pattern-

maker, who had a chat with the moulder, and then the drawings came back because the work could not be done in conformity with them. Draughtsmen were complaining that they had not an opportunity of becoming managers. Personally, he did not know any man managing a works who had been a draughtsman, and he must say the same thing regarding foundrymen, who really ought to have a better chance of filling such a position. They must educate themselves and share their knowledge with one another. A man who kept his knowledge to himself soon got to the end of his stock and found it was not of very much value.

In the course of a discussion suggestions were made that the working conditions in foundries should be improved.

MR. ROE said they could not educate others until they had educated themselves. How many employers or owners of engineering works knew much about the foundry? A very small minority. It was for the foundryman himself to show what was best for the foundry. They wanted to increase the output and at the same time to lessen the labour.

A Few Everyday Foundry Problems.

The CHAIRMAN said during the war period he had learned a lot about copper alloys, but he had not had time to put his views into a suitable form as a paper, because data of that kind had to be very carefully drawn up. One was liable to make mistakes, and if they got into the Press there was much trouble and correspondence. For that reason, by permission of the Secretary, he proposed to confine his remarks on this occasion to a few everyday problems which arose in the foundry, and give his personal experience of the difficulties he had to overcome.

For fourteen years it had been his privilege to manage a works where they made 120 tons per week and had never more than 1¼ tons of scrap. The great majority of the castings did not weigh more than a quarter of a pound, so they could imagine the vast number of articles produced. But although organised to a very high degree, so far as plate moulding and patterns were concerned, they had their problems, and the most frequent ones were blown castings, hard castings, and dirty castings. Probably any foreman would agree with that. No one had a better chance than the moulder to find the reasons for these faults. Taking blown castings, his experience was that they arose from the sand, not because of its chemical constitution, but from the way in which the moulder dealt with it. It was given to him from the sand mill as near to perfection as the foreman knew how to make it from his own experience. On the first day the castings would be all right, on the second day they would be all wrong. It was a rule in his (the speaker's) shop that every Wednesday the whole of the scrap was laid out for inspection, and reports given as to the causes. It was found that one moulder would moisten the sand on the previous evening, and the moisture would spread and to a certain extent equalise itself throughout the sand. Another foundryman left his sand until the morning, and then watered it with a bucket, turned it over two or three times, and then started moulding. The result would be that some of the sand was absolutely dry and rotten and other parts were simply slush. If someone would invent a machine to mix the sand for the moulder it would remove this source of loss. Personally, if he had to deal with a big foundry, he should give each man his sand fresh daily; he would have conveyors to take away the old sand and bring new said moistened to the proper degree. But that would cost money. In any foundry the foreman ought to consider whether he could institute a system by which the sand could be tested as to its moisture, and if this was in excess more sand should be added to bring it to the proper condition before moulding. He thought that would remove at least half the blown castings.

With regard to hard castings, the complaint was that there were bad places—they might be only a quarter of an inch in area. When the tool went over them there was a scream, and the point of the tool was gone. Then the workmen, if on piecework, would complain bitterly of having to work on such castings. That defect would also be removed if the sand were mixed properly.

The excuse generally given for dirty castings was that they were due to dirty metal. He had never known a case of dirty metal carried to its commencement. In his experience they arose from loose sand, and were often due to the moulder beginning to dress his mould up after he had drawn it. If he put it together without any dressing he would probably have a better result.

So far he had dealt with the first of the points set forth in the notice of the meeting—the effect of moisture in the sand. Another point was, how to meet Government requirements in regard to test bars. Since a visit was paid to his works some months back several people had asked him to solve their difficulties in this respect. For 18 months his firm sent test bars to Sheffield every week, and never had a rejection. They had been using ingot copper, but there was a shortage of that, and a merchant offered to supply locomotive bolts which they had used in regular trade before the war and regarded as being good metal. When that was used every one of the test bars was turned down. An analysis of the bolts showed that certain impurities were present. They used ingot copper again, and there had been no rejections since. To spend money freely upon analysis would prevent many difficulties,

The Government had not said, "You will have to adopt a certain mixture in your castings," but they required a standard test. For one metal they gave 12 tons break, 6 tons yield, not less than 15 per cent. elongation; for another, 14 tons break, 7 tons yield, not less than 15 per cent. elongation; for another, 18 tons break, 12 tons yield, not more than 5 per cent. elongation. The last was the biggest problem. Then they got 28 tons, 14 tons, and not less than 15 per cent. elongation. A series of mixings were made, beginning with a 70 to 30 mixture, and the bars on testing gave 60 per cent. elongation. They knew they had got something that was too soft, so they made another mixing 65 to 35, and got the figures 11, 4½, and about 40 per cent. They took it down by degrees until they used 60¼ to 39¼, and got 15, 8 or 9, and 35 per cent. elongation. He might mention that the rule was that test bars were not cast from a melt that was a re-melt; they were made from new metal. They were having tests made at the Manchester School of Technology, and, observing a difference in the results, he made inquiries. The foreman said they had re-melted borings in the shop. They went back to ordinary metal, and the results came out as before. The difference arose from the phosphorus being so volatile. In the one case he thought analysis would have shown that it had passed away, and its effect was lost. After that time they used new metal to make

things for test bars; when they were re-melting they assumed that so much phosphorus and so much zinc passed away through volatilisation. They assumed that in connection with the standard given in the text-book, and from that day to this they had never any trouble.

To get the best results one must watch the temperature at which the metal was run. The foreman moulders that he had known, in non-ferrous metals, contended that the metal should be poured boiling hot to get a good casting. In his opinion that was wrong. Test bars marked A gave 16.7 tons, B 13 tons, C 11 tons. C was run boiling hot. B was run the second casting, and it had stood a bit. A was a medium run. It had been found that it was impossible to burn non-ferrous alloys, but they must not be run at too great a temperature. If they were run at the proper temperature they came out right. His experience was that the best results were got at 600 degrees.

To sum up, the moisture in sand, the temperature at which the metal was run, and chemical composition were the three things to attend to.

BIRMINGHAM BRANCH.

A joint meeting of the Birmingham Branch of the British Foundrymen's Association and the Staffordshire Iron and Steel Institute was held on November 23, 1918, at Birmingham, when Mr. E. H. Broughall gave a paper on "The Practical Use of Denseners and Permanent Moulds." There was a large attendance, presided over by Mr. J. J. Howell (President of the Branch). The Paper and discussion will appear in our next issue.

The PRESIDENT referred to the death of Mr. W. J. Keep, the well-known American author of works on ironfounding. Mr. Keep, said the speaker, was one of the pioneers of the foundry trade from the scientific point of view.

MR. J. SHAW proposed a vote of sympathy with the bereaved family. What the foundry trades owed to Mr. Keep, said the speaker, would perhaps never be known. Keep's testing apparatus was known all over the world, and he was the first to put that kind of testing on a practical basis.

MR. E. H. BROUGHALL, seconding, said that one of the books showing the greatest signs of wear and tear in his (the speaker's) possession was Keep's "Cast Iron." He had derived much valuable information from the useful work which Mr. Keep had carried out in America some years ago.

MR. F. J. COOK, supporting, said that for many years he was in very close touch with Mr. Keep in connection with mechanical tests of cast iron. They had many a tussle, but always remained the best of friends. They were specially indebted to him for his work in connection with shrinkage, as Keep was the first investigator to show the arrest points in cooling.

The resolution was carried by the members rising in their places.

SHEFFIELD BRANCH.

A meeting of the Sheffield Branch of the British Foundrymen's Association was held on December 18, when, in the absence through illness of Mr. J. G. Crowther, the Branch President, Mr. J. R. Hyde, occupied the chair.

Mr. C. WEBSTER, of Rotherham, gave an interesting lantern lecture on "Foundry Practice." He explained that his purpose was to show how an apprentice should be taught the trade, and he illustrated every stage from the making of the pattern to the finishing of the casting by a series of excellent photographs taken by himself, showing some fine examples of the foundryman's work. He prefaced his chatty description of these photographs with some hints to the novice in calculating the weights of castings without the aid of advanced mensuration. He explained that these calculations were based on the known fact that a cubic inch of cast iron weighs 0.26 lbs. Thus a plate 12 by 12 and 1 in. thick would be $144 \times 0.26 = 37.44$ lbs. A plate 12 in. square and 3 in. thick would weigh 112.32 lbs., or practically 1 cwt., and a cubic foot would equal 4 cwts. Mr. Webster illustrated the application of this method to round plates, pipes, etc. The remainder of his lecture consisted of detailed descriptions of the jobs illustrated on the screen.

The CHAIRMAN, in opening the discussion, said there was no doubt his introductory hints in regard to the calculation of weights indicated the right line for an apprentice to be taught that side of the trade, and upon these elementary principles could be built up more advanced calculations.

MR. TOM BROWN agreed that it was desirable that apprentices should be encouraged to calculate the weight of the work they were dealing with. He feared the apprentices of to-day had too many other things with which to occupy their minds, while their education in the elementary schools to-day was concerned with too many fancy subjects, to the neglect of the three R's, upon which alone, in his judgment, a sound and practical education could be built up. If the lad were well grounded in these he could, if he had the brains, acquire the other subjects as the occasion arose. But he thought that much trouble could be saved if Mr. Webster would make more use of the slide-rule, and if apprentices were taught its use.

MR. BARTLE urged the need for provision by which apprentices could follow up their technical education in conjunction with foundry practice. It should also be the business of foremen to see that the lads had a thorough training in the shop.

MR. BROWN pointed out that already provision was made in Sheffield for apprentices to attend part time in the shops and part time at the technical classes, and every encouragement was held out to them to take advantage of this. In one case where they were actually paid for the attendance at the classes only one out of 23 availed himself of the privilege. The fact was that the apprentice of to-day had not his mind on his work, but was encouraged by the foremen and the workmen to think and talk more about the football match or the fight of the previous Saturday or the following Saturday. Foremen should be taught that their interest was dependent upon the thoroughness with which the youngsters were taught their trade.

Other speakers discussed with the lecturer the comparative advantages of the "open-top" and box methods of casting and the use of core barrels, while MR. BRADLEY doubted whether employers would consider the lads' time properly occupied in working out calculations.

LANCASHIRE BRANCH.

A meeting of the Lancashire Branch of the British Foundrymen's Association was held on Saturday, December 7, at the Municipal School of Technology in Manchester, Mr. S. Roe presiding. Mr. S. G. Smith read a Paper on "The Smelting of Cleveland Ironstone," which was illustrated by lantern slides shown and explained by Mr. P. Keekman.

The Paper and discussion will be dealt with in our next issue.

Use of Pulverised Coal.

MR. H. R. COLLINS recently read a Paper on "The Use of Coal in Pulverised Form" before the American Institute of Mining Engineers, from which we abstract the following :—

The purpose of pulverising coal before burning it is to make available every heat unit it contains. Machinery has been developed which will pulverise coal in one operation, delivering it to bins in front of the furnaces at an expenditure of about 17 h.p.-hours per ton, in a medium-sized plant. The cost of the operation depends upon the amount of moisture to be expelled before pulverising, the cost of labour, and the cost of coal delivered at the plant.

The first step is to reduce large lumps to a size suitable for drying uniformly before passing to the mills; this is done in rolls, at a single pass. The second step is the elimination of moisture, in order to facilitate pulverising to great fineness, while also increasing the heating effect and the temperature attainable when the coal is burned. There are other mechanical advantages in the handling of dried coal. Driers are now manufactured which eliminate moisture without distilling any of the volatile matter in the coal; they are fired by hand or with pulverised fuel.

On discharging from the drier the coal is usually passed over a magnetic separator in order to prevent pieces of iron from going to the pulveriser. Two types are used : a magnetic pulley which automatically discharges its collection of iron, and a lifting type, from which the iron is removed by hand when convenient. In the operation of pulverising the coal should preferably be reduced until 95 per cent. will pass through a 100-mesh and 70 per cent. through a 300-mesh sieve. This can be done economically and the product is an almost impalpable powder.

After pulverising, the fuel is conveyed by one of several methods to the point where it is to be used. In several installations the pulverised coal is conveyed a distance of over 900 ft. Where possible a bin should always be installed at the furnace, in order to guard against interruption of supply. Feeders are practically indispensable for regulating the passage of the fuel from the bin to the burner. They are now made quite simple and highly efficient. They deliver the pulverised coal in definite quantities into an air current of fixed volume, where the air disseminates the fuel, surrounding every particle and putting it into condition to develop all its energy. The first to ignite are the volatile gases; these raise the temperature to the ignition point of the solid carbon, and before leaving the zone of heated air every particle has released its last heat unit. The temperatures thus obtained range between 1,900 and 3,500 deg. Fah.; the highest temperature was observed in an open-hearth, when the average temperature of the furnace itself at the same time ranged from 3,100 to 3,200 deg. Fah.

To justify the expense of erecting a special building and installing special machinery to pulverise coal the following advantages in its use may be enumerated :— (1.) Conservation of the country's fuel by utilising every heat unit in the coal, made possible by this method of firing. (2.) Reduction of labour for handling coal to the point of consumption, handling by the fireman, and the removal of ash and unconsumed fuel from the ashpits; practically all of this expense is avoided when fuel is burned in pulverised form. All the coal is received at one point, and thereafter it is handled entirely by automatic machinery, the human element being thereby eliminated, except for supervision, adjustment and repairs. (3.) From actual experience with many grades of coal it may be asserted that every carbonaceous fuel in solid form, from lignites to the graphitic anthracites of Rhode Island, will yield its maximum measure of heat, if burned in a truly pulverised condition. (4.) Coal in pulverised form can be injected into a furnace on a column of air, at very low velocity, thus allowing the expanding gases to liberate their heat without erosion of the refractories. (5.) Pulverised fuel permits the maintenance of a constant temperature in a furnace when the relative amounts of fuel and air have once been set, and the body of the furnace has been brought up to the desired temperature. It will continue thereafter under a "test condition." Furnaces can be operated in this manner hour after hour, as shown by charts of recording pyrometers. The correct relationship between the amount of pulverised fuel and the volume of air, for any desired temperature, can be controlled automatically after adjustment to the particular grade of coal in use, thus using a minimum of excess air. Gas analyses have been obtained as high as 17 per cent. of CO_2. As many questions are asked on the subject of pulverised coal the answers to some of them are as follows :—

(1.) *Grades of Coal.*—For kilns, boilers, or metallurgical furnaces, coals of about 35 per cent. volatile, 50 per cent. fixed carbon, 8 per cent. or less ash, and 2 per cent. or less sulphur, are preferable.

(2.) *Coal High in Ash and Sulphur.*—Coals analysing 25 per cent. ash and 5 per cent. sulphur have caused no trouble in kilns, boilers, or metallurgical furnaces.

(3.) *Storage.*—Storage bins for pulverised coal should be dust-tight and have steep hoppers, enabling old coal to leave the bin completely; accumulations of old coal are liable to fire, smoulder and coke.

(4.) *Why Coal Must be Dried.*—(*a*) To facilitate the pulverising operation, giving the finest product with the least power consumption. (*b*) To permit high temperatures with the least consumption of fuel. Drying the coal also promotes uniformity of temperature. (*c*) Dried coal will flow more easily from bins and through the feeders and burners. Coal should be dried to 1 per cent. of moisture, or less if possible, except that lignites can be readily handled with 5 to 8 per cent. combined moisture.

(5.) *Fineness of Grinding.*—The finer the coal the more rapid its combustion, with relatively higher efficiency.

(6.) *Cost.*—The cost of preparing pulverised coal depends largely on the price and on the moisture content of the coal to be used. On the basis of 200 tons per day of coal containing 7.5 per cent. moisture, at present rates of wages and supplies, and with coal ranging in price from 4s. to, say, 33s. per ton, the cost of pulverising will be between 1s. 3d. and 1s. 8d. per ton, not including overhead charges, interest, or depreciation.

(7.) *Danger from Dust.*—A mixture of coal-dust particles in the air will not ignite until it reaches a certain density; on the other hand, a mixture that is too rich in coal dust has a tendency to smother flame. Pulverised coal should be conveyed from mills to bins in as compact condition as possible; air currents should not be used to convey pulverised coal if any other method can be devised. Leakages should be stopped, to prevent uncleanness and accumulations in inaccessible places. Carelessness in the handling of pulverised coal and poorly designed plants are the only causes of so-called explosions.

(8.) *Essentials of a Feeder.*—A good feeder must absolutely control the flow of pulverised coal to the burner, and prevent any rush or flooding of the fuel. This is essential for positive control of pre-determined temperatures.

(8) *Economy of Pulverised Coal.*—All the benefits of pulverised coal should be taken into account : labour saving, increased fuel efficiency, ability for closer adjustment, absence of smoke, etc. The efficiency of hand-firing depends upon the skill and reliability of the stoker. With the best of attention a loss of 20 per cent. heating value is frequent, and it often reaches as high as 40 per cent., taking into consideration the analysis of the ash and of the flue gas. Mechanical stoker firing is relatively more efficient and more regular than hand-firing, but the feeding of moist coal wastes part of the heat in the least desirable place. Losses also occur in breaking and removing the clinker, in the discharge of unburned fuel, and in the flue gas.

Seasoned Silica Brick from Roof of a Basic Open-Hearth Furnace after 135 Charges.

By C. S. Graham (Scunthorpe).

The three modifications of silica important in this connection are quartz, tridymite, and cristobalite. Each of these three has α and β phases, and each can be converted into either of the others by appropriate heat-treatment. At ordinary temperatures α phases exist which pass into β phases as the temperature rises. These transformations are rapid, whilst the transformation of one mineral into another is as a whole very sluggish, especially near the inversion temperature. The principal inversion temperatures, according to Fenner, are as follows :—*

TABLE I.

575° C. ...	Inversion of α quartz to β quartz.
870° C. ± 10	„ β „ to β_2 tridymite.
1,470° C. ± 10	„ β_2 tridymite to β cristobalite.

Cristobalite may also develop as a metastable intermediate phase below 1,470 deg. C.

Work done by Professor Le Chatelier, and indedependently by Dr. A. Scott† proves conclusively that the stability relations, particularly of tridymite and cristobalite, are still in doubt. Table I. gives the specific gravity and indices of refraction of the above forms of silica.

TABLE I.—*Specific Gravities and Indices of Refraction.*

Composition.	Specific gravity.	Authority.	Index of refraction	
			α	γ
α quartz ...	2.65		1.544	1.553
β quartz ...	2.633			
α cristobalite...	2.33	Endell	1.484	1.487
	2.333	Artificial cristobalite—Fenner		
	2.34	Natural cristobalite—Mallard.		
β cristobalite..	2.21			
α tridymite ...	2.32	Endell	1.469	1.473
	2.27	Artificial tridymite—Fenner.		
	2.28	Natural tridymite—Mallard.		
β tridymite ...	2.32			
Quartz glass ..	2.21	Dana, Endell.		
	2.194	Schwarz.		

The specific gravities in Table I. show that during burning a certain expansion takes place. This permanent expansion, which is of vital technical importance, must not be confused with the temporary expansion. The latter, being the expression of the co-efficient of expansion of silica, is unavoidable, and will disappear on cooling.

Quartz, tridymite, and cristobalite are most conveniently identified by estimating their indices of refraction by the immersion method. According to Fenner, these indices are :—‡

	Mean index of refraction.
Quartz	1.549
Cristobalite	1.486
Tridymite	1.471
Calcium silicates §	higher than that of quartz.

Specific gravity determinations are of little value for discriminating purposes, the reasons being :—(1) small difference between specific gravity of tridymite and cristobalite; (2) some converted grains have a core of unconverted quartzite; (3) Products are invariably filled with microscopic cracks, causing a low specific gravity result; (4) irregular distribution of impurities, such as ferric oxide (specific gravity 5.2) and alumina (specific gravity 4.0).

Quartz may be readily distinguished from tridymite and cristobalite by its high refractive index and double refraction. Between crossed Nicols it may also be identified by its interference colour, which is generally yellow, in contradistinction to the grey of tridymite and cristobalite.

Tridymite may be recognised by its low refractive index, low double refraction, its characteristic needles, and by the lath-shaped and wedge-shaped outlines of its crystals. Between crossed Nicols it gives grey as interference colour. It also occurs as aggregates of overlapping, pseudo-hexagonal plates arranged similarly to tiles on a roof.

The double refraction of cristobalite is generally so low as to be invisible except with the aid of a sensitive (selenite) plate. Tridymite and cristobalite may be identified by studying a portion of the powdered material, immersed in a liquid of about 1.48 index of refraction, which is intermediate between the mean indices of tridymite and cristobalite. By the use of the thermal microscope, Endell found that cristobalite becomes isotropic at 225 deg. to 230 deg. C. The change in volume of cristobalite at 230 deg. is considerable, consequently mercury dilatometer observations offered a sure way of distinguishing cristobalite from tridymite. A specimen of silica brick composed entirely of cristobalite on heating gave the curve shown in Fig 1.* This method of differentiating between tridymite and cristobalite was used by Rieke and Endell, who have gone into this subject with great care.

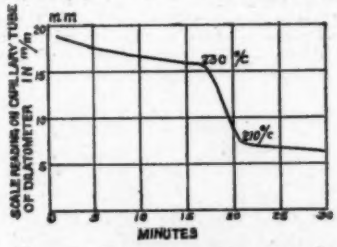


FIG. 1.—CURVE SHOWING EFFECT OF HEAT ON A SPECIMEN OF SILICA BRICK COMPOSED CHIEFLY OF CRISTOBALITE.

* C. N. Fenner :—"Stability Relations of the Silica Minerals."—*American Journal of Science*, ser. 4, vol. 36, page 383 (1913).

† A. Scott, M.A., D.Sc. :—"The Inversion in Silica Bricks." *Transactions of the Ceramic Society*, Session 1917-1918, page 137.

‡ C. N. Fenner :—*American Journal of Sciences*, ser. 4, vol. 36, pp. 351-366 (1913).

§ Rankin & Wright :—"The Ternary System CaO, Al_2O_3, SiO_2."—*American Journal of Science*, ser. 4, vol. 39, p. 74 (1915).

* "Stahl & Eisen" :—Vol. 33, page 1856, Fig. 4 (Nov. 1913).

The wear and tear of silica bricks in basic open-hearth furnaces is to a certain extent due to the abrasive action of the fine basic dust swept through the furnace by the producer gas. Other factors, which also account for this process of denudation, are high working temperatures, local effects of flame, dust in materials charged, liquid metal from bath and charge, and spurting of the slag during boiling of the bath. All these items tend to rapidly promote this fluxing process, which goes on and on, fused material being swept away and fresh surfaces exposed for attack until the bricks are worn away.

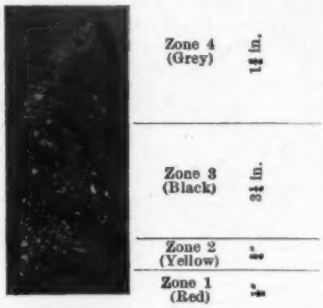


FIG. 2.—LONGITUDINAL SECTION OF A SILICA BRICK FROM THE ROOF OF A 45-TON STEEL FURNACE AFTER 135 CHARGES. (ONE-FOURTH ACTUAL SIZE.)

Examination of the roof of a 45-ton steel furnace after a run of 135 charges showed that this fluxing process had taken place not uniformly over the whole surface, but somewhat irregularly, the maximum wear being near the transverse centre. The brick about to be described was taken from the transverse centre of the above-mentioned steel furnace. After fracturing at right-angles to the exposed face, four distinct zones were distinguished (Fig. 2). The colour of the zone exposed directly to the furnace temperature was grey, being followed by a black, a yellow, and a red zone. The grey and black zones were divided by a distinct line of demarcation, whilst the transition of black to yellow was a very gradual one. From yellow to red there again was a sudden change. After removing skin, the different zones were prepared for chemical analysis and specific gravity determinations. Thin transparent sections

TABLE II.—*Chemical Analyses of the Four Zones and of an Unused Brick from same Batch for Comparison.*

Zone.	Unused bricks from same batch for comparison.	1	2	3	4
Depth of zone.		¼"	½"	3¼"	1¼
Colour of zone.		Red	Yellow	Black	Grey
Chemical analysis :—					
Silica	95.0	93.7	91.4	85.5	88.6
Alumina	1.1	1.1	1.8	1.5	1.0
Total iron expressed as ferric oxide	1.0	1.14	1.52	5 04	5.52
Manganese oxide ...	trace	trace	trace	0.27	0.37
Lime	2.5	3.19	4.10	6.06	4.04
Specific gravity :—					
Bulk...	1.65	1.78	1.80	2.14	2.14
True...	2.37	2.41	2.41	2.44	2.42
Porosity (per cent) ...	30.4	26.1	25.3	12.3	11.6

FIG. 3.

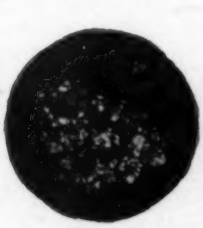


FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

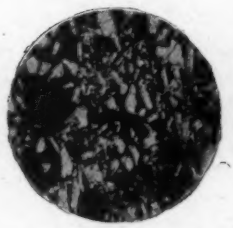


FIG. 8.

FIG. 9.

FIG. 10.

Fig 3.—Unused Silica Brick, showing Fragment of Quartz Rock with Peripheral Layer of Cristobalite embedded in a darker Groundmass. Fig. 4.—Unused Silica Brick—showing same Angular Fragment (as seen in Fig. 3) between Crossed Nicols. Fig 5.—Zone 1. Fragments of Quartz Rock unaltered. Small Individuals of Quartz in Groundmass have disappeared and are replaced by minute Crystals. Fig. 6.—Zone 2. Some Rock Fragments altered. Minute Crystals in Groundmass have grown and become more clearly defined. Fig. 7.—Zone 3. Rock Fragments practically all altered. Unconverted Quartzite noticed in the cores of large Individuals only. Minute Crystals in Groundmass have grown considerably. Fig. 8.—Same as Fig. 7. Crystals of Tridymite in Ferruginous Groundmass. Fig. 9.—Zone 4. Network Structure, both Rock Fragments and Groundmass completely converted. Fig. 10.—Zone 4. Showing Crystals of Cristobalite surrounded by a Ferruginous Glass.

were prepared by the usual petrological methods for detailed examination under the microscope. The chemical analysis, specific gravity, and porosity of an unused brick from the same batch and of the four different zones are given in Table II.

Unused Brick (*Figs.* 3 *and* 4).—Chemical analysis, specific gravity and porosity are normal. Microscopic examination of the thin sections shows numerous angular fragments of quartz rock embedded in a brownish groundmass. Except round the margins, these fragments have generally undergone little change in the kiln. Under a high magnification they are seen to consist of a mosaic of small particles of quartz, closely packed together and separated by thin films which probably consist of ferric oxide and alumina. The groundmass consists of irregular quartz grains of various sizes set in an unresolvable glassy matrix, consisting of silicates of lime and iron and probably aluminosilicates. The smaller grains have been changed to cristobalite and some of the larger ones are only altered round the rims.

Zone 1 (*Fig.* 5).—The chemical analysis of this zone, which has been in contact with the atmosphere, shows an increase in ferric oxide and lime contents. The specific gravity and porosity have undergone practically no change. Although the life of the brick corresponds to a run of 135 charges, thin sections when viewed between crossed Nicols still reveal considerable quantities of unconverted quartzite, which points to the fact that this zone could not have been heated for any length of time above 870 deg. C.—the inversion temperature of quartzite into tridymite. The fragments of quartz rock have undergone little change, but the groundmass has been altered. Some of the irregular quartz grains have disappeared and have been replaced by very small crystals.

Zone 2 (*Fig.* 6).—The lime, ferric oxide and alumina contents have increased. This, according to Le Chatelier, is due to ferrous silicates sweeping the silico-aluminate of lime towards the colder end of the brick. Specific gravity and porosity are practically the same as in Zone 1. The microscope shows some of the quartz rock fragments to have undergone a change. The peripheral layer of cristobalite in many cases is more pronounced. Unconverted quartzite is still present, and some converted quartzite fragments show an unconverted core. The small crystals in the groundmass seem to have become larger and clearer in outline.

Zone 3 (*Figs.* 7 *and* 8).—This zone proves on examination to be much harder than any of the others. It is also more refractory and withstands temperature fluctuations without fracture. The exceedingly low silica content is due to the interpenetration of impurities. In the finely-powdered sample the magnetic portion could be separated with a magnet. Magnetic oxide is the stable oxide of iron at high temperatures, and does not combine with silica. The bulk specific gravity has increased considerably, whilst the true specific gravity is only 0.03 higher than in Zone 2. The reason for this is the high specific gravity caused by the interpenetration of iron oxides, etc., has been practically counterbalanced by the decrease in specific gravity, caused by the inversion of quartzite (spec. grav. 2.65) into tridymite (spec. grav. 2.27) or cristobalite (spec. grav. 2.33). Thin sections show practically complete conversion. Only the very large grains show an unconverted core. The minute crystals which were noticed in Zone 1, and which were more clearly visible in Zone 2, have grown considerably. This zone consists of a ferruginous matrix, in which are imbedded crystals of tridymite and cristobalite. The former occurs as well developed wedge or lath-shaped crystals, which are simply twinned; while the outline of the cristobalite is indefinite. Skeleton crystals of microscopic size are also noticed in the matrix.

Zone 4.—This grey zone, directly exposed to furnace temperatures has undergone more or less fusion. Blowholes are seen here and there. The low percentage of silica is in all probability brought about either by volatilisation of silica or by the interpenetration of impurities or by both. Carbon may be indirectly responsible for this volatilisation of silica by the intermediate formation of silicon monoxide or amorphous silicon carbide. Microscopic examination of thin sections shows both quartz rock and groundmass completely converted into crystals of cristobalite which are surrounded by a ferruginous glass. Figs. 9 and 10 are typical micro-photographs of this zone.

Queries.

Cost of Producing Castings.

Will any readers please give their experience of how best to ascertain the cost of producing iron castings in the foundry, more especially for a jobbing foundry?—"Ironfounder."

We have rather a difficult problem before us in the placing of our foundry, as the ground is very swampy; indeed, at certain times of the year it is flooded to a depth of 6 in. We propose putting tar macadam to a height of at least 9 in., so as to be 3 in. above flood level, and placing on this, sand to a depth of 5 ft. We do not want to risk any danger of an explosion due to accumulation of steam, and imagine that the tar macadam, if heated up, will only melt and remain sealed, thus preventing the damp from getting at the sand. We should like the opinion of your readers.—J. E. S.

THE CLAYCROSS COMPANY, LIMITED, CHESTERFIELD.—This company have forwarded a copy of their diary for the current year, which contains a great deal of useful information as to their products.

PYROMETER PROTECTION TUBES.—The Carborundum Company, of Niagara Falls, N.Y., describes in a recently issued catalogue its Silfrax "A," Carbofrax, Silfrax "B," and Refrax pyrometer protection tubes. The unique chemical and physical properties of carborundum, it states, make that material highly adapted for the manufacture of such tubes. These properties are refractoriness, high thermal conductivity, low co-efficient of expansion, mechanical strength, and resistance to chemical action. The principal use of the Refrax tubes is in steel furnaces, tempering furnaces, glass furnaces, annealing ovens, kilns and under boilers; Silfrax A tubes are used in brass, bronze, and aluminium furnaces; Silfrax B tubes have all the uses of the Refrax tube, and in addition are able to withstand sudden changes of temperature without fracturing. Carbofrax tubes are used for pottery kilns, etc.

Fuel Oil in Metal Melting.

The following notes are abstracted from a Paper by Mr. A. F. Baillie (Engineering Department of Anglo-Mexican Petroleum Company, Limited) before the Manchester Association of Engineers :—

When oil fuel is delivered to customers' works by either barge or rail tank car, it is handled in various manners. Firstly, oil fuel is pumped from barge or rail tank car to overhead storage tanks which should have a capacity that will carry at least one week's supply. These tanks are preferably steam heated to keep the viscosity of the oil as low as possible during the winter months. From these tanks the oil gravitates through a 2½-in. to 3-in. pipe towards the burners attached to the furnaces. This system is called the gravity system.

Secondly, oil fuel is gravitated from barge or rail tank car to underground storage tanks, preferably of the dimensions aforementioned, and again steam-heated. From this storage the oil is circulated around the works by means of a steam or electrically driven pump, the terminal end of the pipeline returning to the storage tank, so that any oil not drawn off to the furnaces is returned to the storage tank. This system is called the circulating system, and is preferable to the aforementioned gravity system, as, due to the high viscosity of oil fuel in the winter months, it is preferable to have a pump pressure behind the oil instead of depending on gravity.

It would be useless to attempt to burn liquid fuel in a similar manner to coal, i.e., if we attempted to burn an oil, say, on a tray, the efficiency obtained thereby would be extremely low, due to the fact that we could not airify the fuel to give it its proportion of oxygen necessary to produce perfect combustion. To obtain this result we require to use oil fuel burners, where it is first necessary to reduce the fluid to particles or molecules that can be mixed with the necessary quantity of oxygen. This process is called "atomisation," and is effected in three systems of burners —(1) air-jet system; (2) steam-jet system; (3) pressure-jet system.

Large users of oil fuel are found in the metal melting industry, melting metal from the low-fusion aluminium to the high-fusion steel. The melting points of these range from 1,000 to 3,000 deg. Fahr. (approximately 540 to 1,650 deg. Cent.).

This, until gas or oil fuel was introduced, was rather a slow process, and I might say that since oil fuel has been used in an intelligent manner the output of each new or converted furnace has been trebled.

Another point which is worthy of notice, and which usually appeals to every works manager, is the fact that when utilising oil fuel the size of the furnace is reduced by 30 per cent., and the working area occupied by a furnace and its adjacent machines is only about 50 per cent. of that of the coal-fired furnace, as a stack of coal occupies a certain amount of space in front of the furnace, and the resultant ashes occupy another certain amount of space behind the furnace. When using oil fuel these spaces may be utilised as furnace pitches instead of carrying accommodation for fuel, oil fuel being carried through pipelines instead of occupying valuable ground space.

The principal metals being so melted at the present moment are aluminium and what is known as "70/30 brass," aluminium being principally used for aeroplanes and motor car work, 70/30 brass being principally used for cartridges.

Aluminium is usually melted in what is known as a "lift-out" crucible, and the metal melted carried to the moulds, whereas brass is melted in tilting furnaces. These furnaces are fixed on a permanent base and are mounted on trunnions so that the furnace can be tilted and the metal run out into moulds, the mould in this case being brought to the furnace.

The average oil fuel consumption for lift-out furnaces when melting low-fusion metals is about 15 per cent., and for tilting furnaces about 10 per cent. of metal melted, i.e., for every 100 lbs. of metal melted the lift-out furnace would consume approximately 1¼ gallons of oil and the tilting type approximately 1 gallon.

Gun Metal and Phosphor Bronze.

The following are particulars of comparative tests between an oil furnace (Buess) and a coke furnace (Baumann). The quantity of oil used each day for melting was measured as follows :—

At the commencement the tank was filled to the overflow pipe. At the end of the day a barrel of oil was weighed, connected to the tank, and the latter again filled to the overflow pipe. The barrel was again weighed, and the difference represented the amount used for fuel. The quantity of coke consumed was arrived at by weighing each basket of coke.

For attending to the oil furnace *one man* was employed, who was paid 4s. 9d. per day of 10 hours. He had a considerable amount of spare time, and could easily attend to a second furnace. For attending to the Baumann furnace with forced working *two men* were necessary (a furnaceman and helper), who were paid 4s. 9d. and 3s. 9d. per day of 10 hours respectively. In the ordinary working only one man is necessary, whilst for fetching and breaking the coke a labourer is employed for about half the time of melting.

Cost of Power.—This was arrived at from the following manner :—As will be seen from the table the furnace took 34½ hours to melt 7¼ tons. To melt 300 tons it would require about 1,380 hours. The power required for the compressor is 8 h.p., and the h.p. per hour costs 5s. 6d. The cost of power with the Baumann furnace is worked out in the same way. The power required for the fan is 4 h.p., and the price is 5s. 6d. per h.p. hour.

Cost of Crucibles.—With both furnaces new crucibles were put in on the day of commencing the trial. The crucible of the oil furnace was still good after 28 charges, and the crucible of the Baumann furnace was also good after 31 charges, so that as far as these go no costs were incurred. The cost of the crucible for the oil furnace, including the stand, is 41s.; the cost of the crucible for the Baumann furnace, including the stand, is 50s.

Lining.—The lining of the oil furnace was not repaired during the trial, and at the finish was still good. The renewing of the lining is required after about 900 charges, and the cost is 40s. The cover is renewed once a year and costs 20s., including labour and fixing. The lining of the Baumann furnace had to be repaired during the time of melting, and was new before the trial started. Furnace usually requires lining four times per annum and costs 30s., including labour.

Cost of Labour.—The total cost of labour is arrived at in the same way as the cost of power, i.e., to melt 7¼ tons costs 18s., therefore to melt 300 tons the labour cost would be £36.

Loss in Melting.—The loss in melting was

measured on September 14, 1912, and arrived at in the following manner:—In each furnace two lots of 2 cwts, of metal were melted and then poured in new crucibles that had been carefully weighed beforehand. These were then weighed again with the metal in same. The difference in weight was the loss in melting. The metal was with phosphor bronze 11.

	Buess Furnace, %	Baumann Furnace %
Melt No. 1	.25	1.75
Melt No. 2	.35	1.65
Average	.30	1.62

Comparative tables of the cost of the Buess and the Baumann furnaces for a production of 300 tons :—

Baumann.

	£	s.	d.
Coke consumption, 12.3 per cent., 36 tons 18 cwts., at 30s. per ton	53	7	0
Power, 960 hours, at 5s. 6d. per hour	13	6	8
Crucibles, including stands, average life 40 charges for 300 tons, 1,500 charges, 37½ crucibles at 50s. each	93	15	0
Lining, four times at 30 s.	6	0	0
Wages for furnaceman, 125 days at 8s. 6d. per day ..	53	2	6
Loss in melting, average percentage of 1.62 per cent., 4 tons 19 cwts...	336	4	0
	£555	15	2

Buess.

	£	s.	d.
Oil consumption at 9.8 per cent., 29½ tons at 60s. ..	88	10	0
Power, 1,380 hours at 5s. 6d. 8 H.P.	38	6	8
Cost of crucibles, including stand, average life 40 charges per 300 tons, 1,500 charges, 37½ crucibles at 41s. ..	76	17	6
Cost of lining twice and one cover	5	0	0
Wages of furnacemen (7½ tons cost 18s.), 300 tons ..	36	0	0
Loss in melting at average percentage 0.3 per cent., 18 cwts. 7½ lbs.	66	0	0
	£310	14	2

	£	s.	d.	
Baumann	£555	15	2	
Buess	310	14	2	
	£245	1	0	saving in favour of oil.

"F.T.J." Bookshelf."

Cast Iron in the Light of Recent Research. By William H. Hatfield, D.Met.—London: Charles Griffin & Company, Limited, Exeter Street, Strand, W.C.2. (12s. 6d. net, postage extra).

This is the second edition of a book which was originally published in 1912 and reviewed in these columns at the time. It is described on the title-page as "revised and enlarged." We are willing to admit the latter statement, as the text has been expanded by 43 new pages and the number of its illustrations has been increased by 35. There are two new chapters in the book, one on the "Influence of Sulphur on the Stability of Iron-Carbide in the Presence of Silicon," and another entitled "Phosphorus Content Permissible in Malleable Castings." Then there are some 15 new lines and an Appendix at the end of the old Chapter XIII. on "Malleable Cast-Iron." About 15 more new lines are to be found at the end of the Section on "The Transverse Test" on p. 248; but otherwise the 15 chapters of the first edition are merely reprints with the exception that Chapter XII. (Heat Treatment of Cast Iron) has been split in two (Chapter IX. and Chapter XIV.) in the new edition. In his Preface the author trusts that should any investigations have been overlooked, his readers will kindly bear in mind the extreme pressure under which all metallurgists are at the present time working, and thus disarms all further criticism. On the other hand, it is only fair to admit that by the additions made the author has somewhat improved a book that was already of a high standard when it first appeared, but the statements "revised" and "in the light of recent research"—as we see—only apply to a limited portion of the second edition.

Aircraft Steels.

A meeting of the Royal Aeronautical Society was held at the Royal Society of Arts on Thursday, December 5, Sir Robert Hadfield, F.R.S., presiding.

The Chairman announced with regret that Brig.-General R. K. Bagnall-Wild, who was to have delivered a lecture on "Shop Practice in Respect to Aircraft Steels," was unable to be present through illness. They were fortunate, however, in having as a substitute his able assistant, Major Philpot, R.A.F.

In a few introductory remarks, the Chairman pointed out that the temperature at which iron was molten or liquid, viz., about 1,520 deg. C., was much beyond white heat—the highest welding temperature in the forge or smith's fire. It was about 4½ times the temperature of molten lead, more than twice that of the melting point of aluminium, and 50 per cent. greater than that of molten copper. It was no wonder, therefore, that at such a high temperature there was liability to take up injurious gases. In the early days of his metallurgical life they tried to reduce and get away from the trouble by producing harder steel, which meant steel with higher carbon, consequently a more liquid steel, and one which melted at somewhat lower temperature, thus to enable some of the gases to escape more readily. The harder steel, however, meant a more brittle steel, and for many years steel castings could not be trusted to perform the severe work required in the modern development of railway, tramway, and engineering work of all kinds. They all owed a great debt of gratitude to the French metallurgists, MM. Euverte, Pourcel and Gauthier, who perfected and introduced successfully the production of ferro-alloys. The German metallurgists never gave help of this nature They only copied, absorbed, and made use of the principles of French, British, American and Swedish metallurgists. It was now possible to produce steel castings of all kinds and weights, providing the sections were not too thin, of perfectly sound material. He believed it would be possible to reduce the call for expensive steels to meet the modern requirements of motor and aeroplane work, and he gave the following figures relating to a steel containing no nickel, chromium, vanadium, tungsten or other expensive element, the result showing material varying according to the heat treatment :—

Yield point.—From 59 to 64 tons per sq. in.

Maximum stress.—From 41 to 72 tons per sq. in.

Elongation.—About 20 to 31 per cent.

Reduction of area.—From 50 to 70 per cent.

Frement shock test.—6 kgm. and 19 bending angle by 21 kgm. by 90.

Izod shock test.—31 ft.-lbs. to 88 ft.-lbs.

Ball hardness.—136 to 350.

With regard to the production of high-tenacity steel, it was possible to obtain material with no less than 125 tons per sq. in. tenacity, 100 tons yield point, and a ball hardness number of 155. With that high tenacity, the Izod test was not specially high, but it reached 14 lbs. The same steel reduced to 106 tons tenacity gave 20 lbs. Izod test, with a ball hardness number of 477.

Major Philpot's lecture, being intended for the students of the Society, was necessarily of an elementary nature.

At its conclusion Dr. W. H. Hatfield said that in aero work welding should be avoided if possible. Tests of welds made under special conditions were misleading, as in the case of aeroplanes made in quantity one had to depend on the workman. In the many welds he had examined he had found practically none free from inclusions or oxides. The future of aeronautics and automobilism largely depended on the development of high-tensile steels.

Mechanical Gas Producer.

The difficulty in obtaining at the present time suitable coals for gasification, necessitates the serious consideration by gas-producer users of any improvements in the construction of producers that will overcome the problems of dealing with the fuels which are available. The Kerpely revolving-grate producer was primarily designed for the gasification of low-grade fuels, and it has proved its merits in many large installations in steel and other works in this country. The main features of the original design of this producer (which have previously been fully described) may be summarised as follows:—(1) The water-cooled jacket, which prevents the heavy formation of clinker on the walls of the producer that invariably occurs in brick-lined producers. (2) The revolving grate of *polygonal* shape with cone fixed eccentrically upon

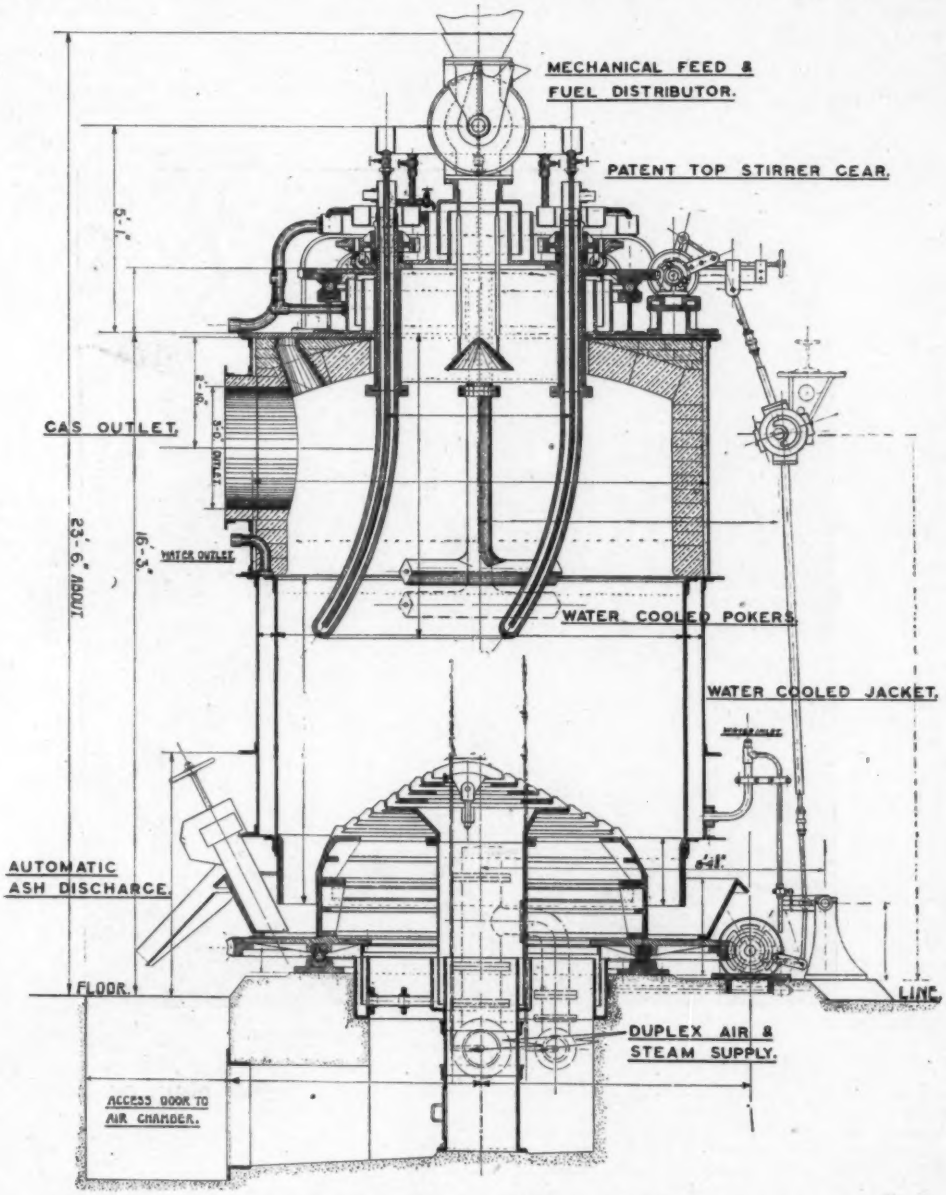


FIG. 1.—SECTION OF KERPELEY MECHANICAL GAS PRODUCER.

the water trough, which has a continuous (not an intermittent) action in crushing any formation of clinker that may exist. The clinker when entering the ash zone is caught by the numerous edges of the grate and crushed against the seal apron fixed at the bottom of the water jacket. The shape and eccentricity of the Kerpely grate ensure the automatic discharge of the ash and clinker into the water trough. (3) The automatic ash discharge, which clears the ash and clinker from the water trough. (4) The duplex air and steam supply, which conveys the blast separately to the inner and outer sections of the revolving grate, and, being transmitted to the fuel bed through the apertures of the grate, ensures effective control of, and uniform combustion in, the fuel bed.

Messrs. E. G. Appleby & Company, Limited, who own the patent rights in the Kerpely gas producers for Great Britain, Canada, America, and other English-speaking countries, and who are responsible for the development of this producer for dealing with British fuels, have continually improved the construction since the first producer was installed, about ten years ago, and their latest developments include the provision of mechanical feeds and fuel distributors and mechanical pokers (Bentley's system) for dealing with coking and coking fuels.

The mechanical feed and fuel distribution is designed to ensure an even distribution of the fuel over the whole fuel bed and a regular delivery of the fuel into the producer to suit the rate of gasification. The mechanical feed is of the rotating-drum type, the drum having four chambers; it is operated by ratchet wheel and pawls, and is easily adjustable whilst working to give any rate of feed up to the full working capacity of the producer. The feed drum can be operated in either direction at will. The fuel is delivered on to a conical form of fuel spreader which gives even distribution over the fuel bed. Mixed fuels can be used, from small up to about 3-in. cube in size.

The mechanical pokers maintain a level and solid fuel bed, which ensures a constant supply of good-quality producer gas. There are four pokers, two of curved type and two with T heads, and they are set at different levels and to follow each other in the upper portion of the fuel bed; the shorter T poker acts as a leveller to the top of the fuel bed. The pokers are fitted into a poker-bearing ring and top plate, and, actuated by a simple form of vari-

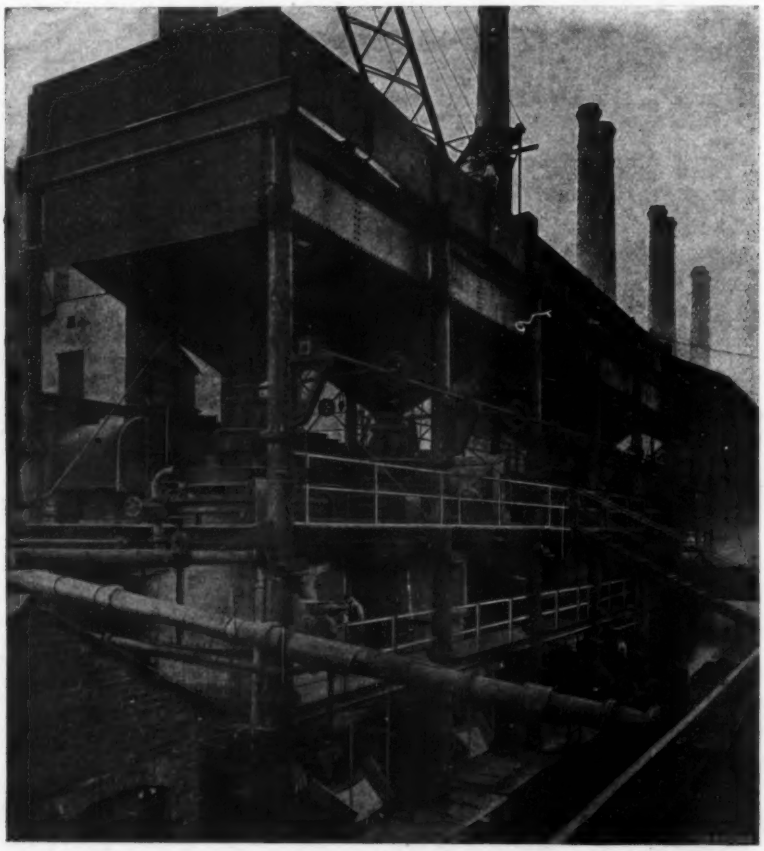


FIG. 2.—BATTERY OF KERPELY MECHANICAL PRODUCERS.

able-speed worm-gear, the top plate revolves and the pokers also rotate on their own axes, thus maintaining a slow and continuous movement.

A sectional diagram of the Kerpely mechanical producer above described is shown in Fig. 1, and Fig. 2 illustrates a battery of these producers installed at a South Wales steelworks. This plant has now been working at its full capacity for sixteen months, and the results now recorded are such as are obtained under every-day working conditions.

The fuel gasified is of good calorific value, but is physically a bad fuel for producer purposes, containing 30 per cent. to 40 per cent. of small below 3-16-in. It also cakes and clinkers badly. The quantity of fuel gasified in the fixed-grate producers (10-ft. shell diameter) in the works averages about 6 cwts. per hour, and in the Kerpely revolving-grate producers (10-ft. diameter) the average quantity gasified is 15 cwts. per hour. The comparative gas analyses are as follows:—

	Fixed-grate producers. Per cent.	Kerpely revolving-grate producers. Per cent.
CO_2	10.1	3.3
CO	15.1	27.5
H	13.7	10.8
CH_4	2.7	2.9
N	58.4	55.5

It is found with the fixed-grate producers that there is some difficulty in working owing to the excessive labour required in poking to deal with the caking and coking fuels, the high steam consumption, the difficulty of cleaning owing to the hard clinker, and the excessive carbon left in the ash (about 17 per cent.); whereas, with the Kerpely revolving-grate producers no hand labour is required for charging the fuel, poking, or discharging the ash, the steam consumption is very low, the producers are mechanically cleaned, and the carbon left in the ash is only about 7 per cent.

Horn Automatic Reverser.

We have received from the Horn Automatic Machine Company, Inc., of Shukert Building, Kansas City, Mo. (U.S.A.,) a brief description of their automatic reverser, for reversing the gas in open-hearth furnaces, heating furnaces, and soaking pits. The machine is claimed to be a great money saver in a steel plant, which will increase the output, and, at the same time, prolong the life of the furnace, securing the maximum amount of heats by automatically reversing the gas at proper intervals. It is claimed to be positive in operation, easy and simple to install, with few working parts, and nothing to wear out or get out of order, as it works but four minutes per hour when reversing at fifteen-minute intervals. It can be made to reverse as many times per hour as desired, and the furnace can be reversed by hand at any time without interfering with the machine.

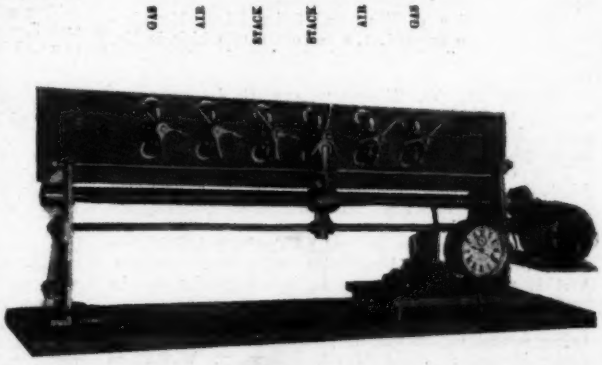
The machine is the invention of Mr. John Horn, the inventor of the Horn gas valve manipulator, in conjunction with which this machine works, and which is stated to be now in use throughout the United States Steel Corporation's plants. Mr. Horn was superintendent of open-hearth furnaces for the Steel Corporation for 13 years.

Reconstruction in the Brass and Copper Trades.

The subject of reconstruction in the brass and copper trades was considered on Friday, November 29, at a conference held under the auspices of the Ministry of Reconstruction in the large lecture theatre of the Birmingham and Midland Institute. A preliminary conference was held on July 17, in Birmingham, and an Advisory Committee was appointed then to consider the demarcation of the boundaries of the industry, the grouping of the trades, and the further organisation of the industry as a whole. The Committee recommended that if a Council or Committee was to be set up the present organisations both of employers and of employees should not be thereby interfered with, but that they maintain their present functions. The grouping of the trades into nine groups, each divided into sections, was recommended as follows: (1) Raw Material Trades; (2) Rolling and Drawing; (3) Brassfoundry, etc.; (4) Engineering; (5) Lamps—carriage, motor-bicycle, ships', etc.; (6) Wrought and soldered work; (7) Naval screws, rivets, etc.; (8) Locks and latches; (9) Bedsteads. Subsidiary users of brass and copper—as, for example, makers of scales, weights, scientific instruments, musical instruments and jewellery, the Committee recommended should be excluded. It was left open for further consideration whether metal merchants, dealers and brokers, and export merchants should be included. It was suggested that aluminium should be included, but not the soft metals, tin, lead, etc.

At last week's meeting representatives of the brass and copper trades, comprising delegates from various parts of Great Britain, attended, including representatives of various Associations of employers, and workmen's Associations. Mr. Ernest J. P. Benn (Chief Industrial Commissioner for the Ministry of Reconstruction) presided.

A discussion ensued, and complaint was made that some outside firms and districts had not been consulted. Eventually, on the motion of Mr. Joseph Walker, seconded by Mr. W. F. Green, the Advisory Committee was unanimously re-elected and given power to add to its number. This, it was pointed out, would enable representatives to be appointed from districts and trades which had not yet been represented. It was understood that measures for the formation of ten Interim Reconstruction Committees would form part of the work of the Advisory Committee.



Horn Automatic Reverser.

Trade Talk.

MESSRS. ROMEN & HAMMOND have removed to Central House, 34-36, Oxford Street, London, W.

THE London office of Richard Garrett & Sons, Limited, Leiston, Suffolk, is now in the charge of Mr. G. P. Mair.

THE MINISTER OF MUNITIONS has suspended the Chrome Ore Order, which prohibited dealings except under permit.

SANDYCROFT, LIMITED, 9, Queen Street Place, London, E.C., have removed to 4, Broad Street Place, London, E.C.2.

ALLDAYS & ONIONS PNEUMATIC ENGINEERING COMPANY, LIMITED, will in future be known as Alldays & Onions, Limited.

THE EAST CUMBERLAND NATIONAL SHELL FACTORY, which was established at Carlisle in 1915, has ceased active operations.

THOMAS FIRTH & SONS, LIMITED, of the Norfolk Works, Sheffield, propose discontinuing the manufacture of edge tools.

IT has been decided to form the Sheffield Cutlery Trades Technical Society. Mr. W. H. Bolton has been appointed hon. secretary.

MESSRS. J. A. CLABOUR AND J. B. CLABOUR, engineers, Guiseley, trading under the style of J. B. Clabour, have dissolved partnership.

A FIRE at the Summerhill Foundry, Prince's End, Birmingham, of Messrs. Chas. Lathe & Sons, has caused considerable damage.

THE POWER GAS CORPORATION, LIMITED, have acquired the business and patents of Messrs. Lymn & Rambush, makers of gas-producing plant.

THE VICTORIAN HOUSE OF REPRESENTATIVES has passed a Bounties Bill, to encourage the establishment of an iron and steel industry in Australia.

THE MINISTRY OF MUNITIONS have this week revoked the Cranes Order, 1916, and the Motor Engines and Vehicles Order, 1917, as from December 6.

MR. M. JENKS, 6, Old Jewry, London, E.C.2, has been appointed liquidator of the A.E.G. Electric Company, Limited, 6, Old Jewry, London, E.C.

MR. C. T. APPLEBY, 26, Corporation Street, Birmingham, has been appointed liquidator of Piston Rings, Limited, 38, Waterloo Street, Birmingham.

THE CORRA ENGINEERING COMPANY, LIMITED, is being wound up voluntarily, with Mr. T. F. Wild, 22-28, Broad Street Avenue, London, E.C., as liquidator.

MR. F. W. MARSHALL, 152, Gresham House, Old Broad Street, London, E.C., has been appointed British agent for the Société Minerais & Metaux, of Paris.

THE shareholders of National Alloys, Limited, will meet at 22, Queen Street, London, E.C., on January 21, to consider the liquidator's account of the winding-up.

AN Association of Flint and Silica Flour Manufacturers has been formed, the secretary of which is Mr. F. A. Campbell, Wharton Lodge Works, Winsford, Cheshire.

MESSRS. H. W. HODGSON AND G. L. HODGSON, trading as E. Hodgson & Sons, engineers, Northgate Mills, Northgate, Cleckheaton, have been adjudged bankrupt.

THE secretary of the Consett Iron Company, Limited, says that the statements as to a proposed amalgamation between Dorman's and Consett are incorrect.

PREMISES have been secured by the British Scientific Instrument Research Association at 26, Russell Square, W.C.1, where offices and research laboratories will be equipped.

THE CHESTER ENGINEERING COMPANY, LIMITED, is being wound up voluntarily, with Mr. S. Cole, Sardinia House, Sardinia Street, Kingsway, W.C.2, as liquidator.

MESSRS. M. ROSEN AND M. SILVER, engineers, 222, 224 and 226, Mile End Road, London, E., trading under the style of Rosen & Silver, have dissolved partnership

THE engine works department in London of Sir W. G. Armstrong, Whitworth & Company, Limited, has been removed to 3, Blenheim Street, New Bond Street, London, W.1.

WE are advised that the London Iron and Steel Exchange has been formed, not only in the interest of iron and steel, but of all metals, including brass, tin, lead and copper.

EXCELLENT progress has been made with the extensions to the Toledo Steel Works, Sheffield. The new buildings are finished, the furnaces erected, and the general equipment is nearing completion.

IN view of the altered circumstances brought about by the armistice, the Controller of Timber Supplies has found it possible to dispense entirely with permits for the purchase of home-grown timber.

MR. J. H. STUDLEY has established himself in business at 25, Bond Street, Leeds, as an iron and steel merchant. He was previously connected with the business of Leigh & Sillavan, Limited, Manchester.

LAMINATED GEARS, LIMITED, will shortly commence the erection of a new machine shop at their Sedgley Road works, Sheffield, which when finished will, it is anticipated, enable them to double their present output.

LAST month the Falkirk Iron Company, Limited, entertained their employés of the Castlaurie Works to commemorate the successful conclusion of the firm's work during the war. Mr. Kidston, the manager, presided.

THE Minister of Munitions has suspended the Aeroplanes (Experimental Manufacture) Order, 1917, the Aero-Engines (Experimental Construction) Order, 1918, and has revoked the Lorries and Trailers (Returns) Order, 1917.

THE clause in the London scrap lead trade to the effect that 10s. per ton extra is allowed for lead delivered to London warehouses has apparently been discontinued, and in future all such metal is to be carted free in the London area.

ACCORDING to the Director of the War Trade Department, Westminster, S.W.1, export trade with Holland can now be resumed under licence, and that his Department is prepared to receive and consider applications for the grant of licences.

THE NORTON HARTY ENGINEERING COMPANY are making additions to their Central Works, Great Bridge, Tipton, Staffs., by the erection of a new constructional shop 120 ft. long by 55 ft., the floor of which will be served by a 5-ton crane.

THE IRON, STEEL AND ALLIED TRADES FEDERATION, the offices of which have been in Middlesbrough, is, we understand, to be disbanded. The work of collecting the statistics of the British iron trade will be taken over by the new National Federation of Iron and Steel Manufacturers.

THE sale of the business of the Lion Constructional and Engineering Company, Limited, to the Lion Company, Limited, for the sum of £30,000 has been confirmed by the shareholders. The former company is now being wound up voluntarily, with Mr. H. C. Mitchell, 1, Church Court, Clements Lane, London, E.C., as liquidator.

M. B. WILD & COMPANY, LIMITED, have built new offices on the front of their works in Argyle Street, Nechells, Birmingham. The offices are to be further extended at an early date. The upper floor in the new building has been laid out for the drawing office, the demands upon which had long since outgrown the accommodation in the old offices.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, have opened a branch office at Manchester at Grosvenor Chambers, Deansgate. The office is under the management of Mr. G. W. Turner, and all matters relating to pig-iron, cast-iron pipes, special castings, ironstone and slag sales in that district will be conducted from the address mentioned.

THE INSTITUTION OF MINING AND METALLURGY has

been appointed by the Ministry of Labour as the central authority for the demobilisation of pivotal men connected with metalliferous mining and non-ferrous metallurgy. This institution is also assisting in the demobilisation of those men who wish to resume their studies at the Royal School of Mines and other mining colleges.

FURTHER steps for forming a Whitley Committee were taken at Birmingham on November 29, at a conference of brass trade employers and operatives. A report was presented in which the opinion was expressed that any Reconstruction Committee set up should not interfere with the functions of the lasting organisations in the trade on either side, of which it was mentioned there were fifty-eight.

ON December 1 all restrictions as to the sale or purchase of calcium carbide were removed, subject to a maximum price to consumers of £40 per ton for quantities of 1 cwt. and over (granulated 10s. per ton extra). It is anticipated that supplies are available for all purposes, and will be distributed through the ordinary trade channels, but should the exigencies of the shipbuilding industry demand it, the Government reserves the right to give preferential deliveries.

IN view of the recent rapid progress of events affecting the British engineering industry and the export trade, the council of the British Engineers' Association have decided to strengthen their administration by the appointment of a director, who will be the chief organising and executive officer of the Association. To fill this position the council have secured the services of Mr. D. A. Bremner, O.B.E., who, as an engineer, business organiser and administrator, has had a wide experience at home and abroad.

MR. J. G. BUCHANAN has been elected chairman of the Iron, Steel, Tinplate and Metal Merchants' Section of the London Chamber of Commerce, with Mr. P. G. Donald as deputy-chairman. At their meeting on November 20 the members decided to refer to the British Federation of Iron, Steel and Tinplate Merchants the question of the suppression of the Comité des Forges or any other body as sole buyers of material on French account, in regard to which the manufacturers' sub-section had forwarded a resolution.

G. WINCOTT, LIMITED, Sheffield, have received orders from the Bynea Steel Works, Limited, Llanelly, for a 50-ton Siemens basic furnace, together with a gas producer—the sixth of such furnaces to be built for the company by Messrs. Wincott; Richardsons, Westgarth & Company, Limited, for a plate heating furnace and producer, to be installed at the West Hartlepool works; and John Lysaght, Limited, for a plate annealing furnace, of the continuous bogie type, with a length of 124 ft., for installation in the Australian works of the company.

THE following resolution was unanimously passed at a specially convened meeting of members of the London Metal Exchange, held on December 5. The question as to the re-admission to the Exchange of subscribers of enemy origin having been raised last week without the authority of the governing bodies of this Exchange, the unanimous decision of the members of the London Metal Exchange is that subscribers of enemy origin should not be re-admitted, and that the committee and directors be requested to take all possible and necessary steps to this end.

IN regard to the new scale of export steel prices, limiting the merchants' margin of profit to 1¼ per cent., the Ministry of Munitions has issued the following notice:—"The question has been raised as to the exact application of the regulation limiting merchants' profits to 1¼ per cent. This is intended to apply to business which is worked strictly on a c.o.d basis. In cases where it is not customary or possible to work on this basis, the merchant is entitled to add to the price to be charged to the customer abroad a reasonable margin to cover him for extended credit and other contingencies."

THE following agencies have been established by Sir W. G. Armstrong, Whitworth & Company, Limited, Openshaw, Manchester, in connection with their tool steel and small tools business:—London and Southern district: Mr. E. Wilson, 8, Great George Street, Westminster, S.W.1. Scotland and Ireland: Mr. A. S. Jones, 137a, St. Vincent Street, Glasgow. Midland district: Mr. W. Todd, 158-161, Great Charles Street, Birmingham. North-Eastern district: Mr. J. D. Smith, Pilgrim House, Pilgrim Street, Newcastle-on-Tyne. Lancashire and Wales: Mr. T. W. Etchells, 5, John Dalton Street, Manchester.

ANOTHER combination of interests in the iron and steel trade has been effected on Tees-side, the announcement being made that the Seaton Carew Iron Company, Limited, has affected an alliance of interests with the Furness group. The new arrangement came into force on January 1. This is the second step taken recently by Lord Furness in the direction of extending his control of the iron and steel trades. The ironworks and foundries of Cochrane & Company, Middlesbrough, have already been acquired. The Seaton Carew Company have a capital of £100,000, and debentures amounting to £32,500. The plant comprises four blast furnaces.

THE following war regulations have been wholly removed:—7a.—Prohibition on exhibition prejudicing production of war material. 8b.—Prohibiton on occupiers of engineering factories canvassing for certain employés. 15b.—Power to require particulars of goods held for enemy benefit. 18b.—Restrictions on publication of inventions and designs. 29c.—On certain persons entering shipyards. 41a.—Duties to be observed by employer of male persons of 16 years or over. 41ab.—Production of evidence as to liability to military service of man of military age about to be employed. 41c.—Prohibition on transmission of money or credit to or from country under blockade. 45a, 45b, 45c, 45d.—Powers respecting certificates of exemption from military service. 53b.—Testing accuracy of information given as to employés.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, have entered into a working arrangement with Messrs. James Oakes & Company, of the Alfreton Ironworks, Derbyshire, under which the Stanton Company will from January 1 act as sole selling agents for the products of Messrs. James Oakes & Company's blast-furnaces and foundries. The Stanton Company have in the past had the largest output of cast-iron pipes of any foundry in Great Britain, and their recent amalgamation with the Holwell Iron Company, Limited, of Melton Mowbray, has given them a predominating position in the cast-iron pipe trade in this country. Messrs. James Oakes & Company's foundries have been devoted largely to the manufacture of flange pipes, special castings for chemical and coke-oven plants, circulating, cooling, boiler, and electric-power plants.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, of Openshaw, Manchester, are placing upon the market a new high-speed tool steel. It is not claimed that the new steel possesses any marked advantage over the high-speed steel of commerce for cutting mild steel or other soft material, the "A. W. Super Premier" steel being specially designed for metal shifting against time, when dealing with very hard, high-tensile steels, as also for the tools for automatic machines, where it is imperative that the cutting edge should have the longest possible life. The steel has, needless to say, been thoroughly proved in the Openshaw Works, where, on a recent test extending over a period of nine hours turning nickel chrome air vessel forgings, with an average cut of ⅜ in. and a feed of 1-16 in., the amount of metal removed was 1 ton 14 cwts.

THE board of directors of the London Metal Exchange have now passed the following rule, to come into operation on December 31 1918:—"On January 1, 1919, all subscribers whose nationality of origin is or was German, Austrian, Hungarian, Turkish (but not

including Armenian), or Bulgarian, shall cease to be subscribers and shall cease to be entitled to any of the rights of subscribers, and the directors shall refuse to accept the renewal of the subscriptions of any such subscribers, whose membership of the Exchange shall absolutely cease and determine on such date. Any subscriber whose nationality of origin comes within those above described and who may renew his subscription shall not thereby obtain any of the rights of a subscriber. The directors may in any case in which they think it necessary require any subscriber offering or proposing to renew his subscription to furnish them with evidence satisfactory to them as to the nationality of origin of such subscriber."

THE arrangements have now been completed in connection with the formation of the British Metals Corporation, Limited. The authorised capital is £5,000,000, divided into 500,000 shares of £10 each, of which 200,000 shares have been privately subscribed, principally by metal and financial interests. There will be no public issue of capital. The board includes Mr. C. V. Sale, the deputy chairman of the Hudson's Bay Company; Mr. C. R. Rudd, Sir Charles Fielding, Sir Lionel Phillips, Major A. J. Hugh Smith, Mr. Andrew W. Tait, and Mr. William Tennant. Mr. A. S. Clift will act as alternate director so long as Sir Charles Fielding remains Director-General of Food Production. It is understood that Mr. Cecil Rudd, head of the firm of Messrs. Vivian Younger & Bond, and chairman of the Metal Exchange for a long time past, will become managing director. Mr. F. G. Palin has been appointed secretary to the Corporation. The Treasury director has not yet been appointed.

THE report of war work in connection with the Applied Science Department of the University of Sheffield has been issued. The Engineering Department have a total output of 6,250 gauges to their credit. The total output of 18pdr. Hr. shells has been 12,216. The possibility of making cupro-nickel in the Sheffield area for the first time, and the subsequent development into an industry involving a capital outlay of £20,000 per week, was due entirely to experimental work conducted by the staff of the non-ferrous and electro-metallurgical departments of the University, and the total output, when the contract was closed, owing to the Ministry having ample supplies in stock, was 1,354 tons. The non-ferrous department, in the casting of quick-firing brass, produced 256 tons in nine months. The electrical engineering department, with the local staff of the aeronautical inspection department, has tested and reported upon 27 samples of magnetic steels, 144 standard magnets, 150 tests on non-magnetic (nickel steel) steels, and 35,000 magnets. Since December, 1916, the staff of the applied chemistry department has been engaged on investigations on carbonisation of coal.

MESSRS. RUSSELL & COMPANY, of Port Glasgow, have acquired the business of William Hamilton & Company, Limited, shipbuilders, Port Glasgow. Some years ago Messrs. Russell acquired the Port Glasgow yard of Messrs. A. Rodger & Company. Later they purchased that of Robert Duncan & Company, Limited, and later still the extensive marine engineering works of David Rowan & Company, Limited, Glasgow, so that they have now four different shipyards in Port Glasgow and engineering works in Glasgow. Their yards have berths in which over 30 vessels can be constructed simultaneously. The yard of William Hamilton & Company, Limited, which will be formally taken over at the New Year, has eight large berths. An arrangement has been made whereby Messrs. James and Henry Lithgow (of Messrs. Russell & Company, Port Glasgow) will purchase the business of Dunlop, Bremner & Company, Limited, shipbuilders and engineers, Port Glasgow. The firm have no five shipyards in the burgh — the two mentioned, their original Kingston yard, and those of Messrs. A. Rodger & Company and Messrs. R. Duncan & Company. They also own the extensive engineering works in Glasgow of Messrs. D. Rowan & Company, and are lessees of the Garvel Graving Dock, Greenock.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Allen, A. W and Ryding, H. C. Manufacture of open-hearth steel. 19168. November 21.

American Manganese Steel Company. Method of recovering manganese steel. 18,526. November 12.

American Manganese Steel Company. Method of making manganese steel. 18,526. November 12.

Ashcroft, C. P. Cyclic process for simultaneous production of magnesium metal or alloys and alkali chlorates. 20,714. December 12.

Ballantine, W. B. Manufacture of alloys. 19318. November 23.

Beeston, W. G., and Stevenson, J. J. Furnaces for drying foundry cores, annealing tinplates, etc. 20,231. December 6.

Bloxam, A. G. (*Stabilimenti Biak—Ing. A. Pouchain*). Aluminium alloys. 17,743. October 30.

Brookfield, D., Tylor & Sons, White, H. T., and Garnet, J. Tilting-mechanism for crucible smelting-furnaces. 19,382. November 25.

Chapman, R. E. Cutting or welding metals. 17,696 October 30. (United States, June 29.)

Charpy, G. Process for eliminating faults due to piping and segregation in ingots of steel, etc. 20,377. December 7. (France, July 29.)

Climie, W. Gas producers. 20,390. December 9.

Chisholm, F. J., and Freeborn, R. Moulds for ingots, etc. 19,749. November 29.

Davis, H. N. Reversible regenerative gas-fired furnaces. 20,456. December 9.

Davis, H. N., and Twigg, W. R. Crucible furnaces. 18,631. November 13.

Falvet, F. E. Manufacture of steel. 18,518. November 12.

Falvet, F. E. Manufacture of iron or steel, or their alloys. 18,519. November 12.

F.I.A.T. Soc. Anon. Electrical furnaces. 20,746. December 12 (Italy, December 12, '17.)

Gasche, F. G. Perfecting metal ingots. 18965. November 19.

Gasche, F. G. Machine for perfecting ingots. 18966. 18967. November 19.

Hadfield, Sir R. A. Manufacture of alloy steel. 18,684. November 14.

Hadfield, Sir R. A. Refining steel. 18,685. November 14.

Hall, H. C. Aluminium alloy. 17,579. October 28.

Harrison, J. Electric furnaces. 20,858. December 14.

Haywood, W. G. Copper-aluminium alloy. 20,550. December 10.

Imbery, A. Electric muffle furnaces. 20,375. December 7.

Imbery, A. Hardening and tempering metal articles. 20,385. December 7.

Kohler Company. Process of producing cast metal objects. 17,734 October 30.

Kuehnrich, P. C. High-speed tool steel. 18,413. November 11.

Leslie, R. M. Apparatus for testing hardness of metals, etc. 19,866. December 2.

Marks, E. C. R. (*American Manganese Steel Company*). Method of recovering manganese steel. 18,525. November 12.

Marks, E. C. R. (*Kohler & Co.*). Process of producing cast metal objects. 17,734. October 30.

Mate, W. C. A. Furnaces for rendering metal articles non-oxidisable. 18,810. November 16.

Metals Disintegrating Company. Process of disintegrating metal. 20,080. December 4. (United States, December 20, '17.)

Metals Disintegrating Company. Metal disintegrating apparatus. 20,081. December 4. (United States, December 20, '17.)

Mitchell, F. A. Die-casting machines. 18,720. November 15.

Paton, J. D. Crucibles for molten metals. 18,606. November 13.

Pritchard, P. Foundry moulding machine. 20,492. December 10.

Quasi Arc Company. Electric-welding apparatus. 20,762. December 12.

Readett, W. J. Method of electrically treating steel, etc., and hardening steel, etc. 17,932. November 2.

Robertson, E. F. Cores for use in die casting. 17,861. November 1.

Rolls-Royce, Limited. Aluminium alloy. 17,879. October 28.

Rossi, C. Process for production of an acid-proof metal alloy, and product thereof. 20,840. December 13. (Italy.)

Rourke, C. J. Furnaces for rendering metal articles non-oxidisable. 18810. November 16.

Sherwood, W. J. P. Surface hardening of steel and steel articles. 17,903. November 1.

Soc. Electro-Metallurgique Francaise. Electrodes of electric furnaces. 19,756. November 29. (France, December 3, 1917.)

Stansfield, J. W. Providing blast or draught for furnaces, etc. 18411. November 11.

Vickers, Limited. Moulding, etc., apparatus. 17,844. October 31.

Vickers, Limited. Surface hardening of steel and steel articles. 17,903. November 1.

Wigley, F. S. Crucible furnaces. 18,304. November 8.

MOULDING MACHINES

OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.

Type "A" Duplex Machine for Pneumatic Power.

Fitted with self-adjusting Rammer Head which accommodates itself to any varying depth of pattern.

OVER 50 COMPLETE MOULDS PER HOUR HAVE BEEN PRODUCED

ON THIS MACHINE WITH UNSKILLED LABOUR.

One of many that we have installed in various Munition Work Centres.

JAMES EVANS & CO., BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

Deaths.

THE death is announced of Mr. J. Geoghegan, sen., of the Banbridge and Newry Foundries.

MR. E. TONKS, of Messrs. E. Tonks & Sons, lock manufacturers, Temple Works, died recently.

THE death has occurred of Mr. J. R. Dudley, tool manufacturer, of Norbriggs, Staveley, at the age of 80 years.

MR. L. W. DENLEY, secretary to J. Nichols & Son, Limited, Cheapside, Birmingham, died recently, aged 53 years.

MR. E. J. HAMILTON, general superintendent of the Duquesne Works of the Carnegie Steel Company, died recently.

MR. W. K. CAPARN, a director of J. W. Caparn, Limited, ironfounders, Walsall, has died at the age of 28 years.

THE death is announced from Milan of Signor Ernesta Breda, head of the Breda Engineering Works, of that city.

THE death is reported of Mr. H. C. Walker, a director and chief electrical engineer of Waygood-Otis, Limited, aged 41.

MR. V. W. SINTON, a director of J. Mackie & Sons, Limited, Springfield Foundry, Belfast, died recently at the age of 37 years.

MAJOR H. F. WOOD, 9th Lancers and Royal Air Force, who died on December 11, was the founder of the aviation section of Vickers, Limited.

THE death is announced at the age of 88 years of Mr. J. Wright, of Messrs. J. & T. Wright, Fir Tree House Foundry, Platt Bridge, near Wigan.

MR. J. A. DOTCHIN, at one time head of Dotchin & Son, engineers' factors, etc., 35, High Bridge, Newcastle-on-Tyne, died recently at the age of 32 years.

MR. H. R. CHESSHIRE, younger son of Mr. J. H. Cheshire, and a director of Izons & Company, Limited, of West Bromwich, has died at the age of 29 years.

WE regret to learn that Mr. Robert Twiggins, of the Scottish Branch of the British Foundrymen's Association, and son of a member of the Branch Council, was killed in France in October last.

THE death occurred recently of Mr. J. Howard, a director and secretary of Geo. Howard, Limited, iron and steel merchants, Folly Lane, Warrington The deceased gentleman was 42 years of age.

MR. G. D. WALKER, who died in Sheffield from pneumonia following influenza, at the age of 28 years, was manager of the Siemens Department of John Brown & Company, Limited, Atlas Works, Sheffield.

MR. E. SHARER, late of Scotstoun House, Glasgow, and up to a few years ago shipyard director at the Dalmuir Naval Construction Works of Wm. Beardmore & Company, Limited, has died at Gosforth, at the age of 62 years

THE death has occurred from influenza, at his residence in Claremont Street, Old Hill, of Mr. Rupert Harris, the head of the firm of Messrs. R. Harris & Company, iron and steel merchants. Mr. Harris was 29 years of age.

THE death is announced from Madrid of Don Leandro Cubillo, for many years director of the State Cannon Factory at Trubia, Spain. The deceased was a member of the British Iron and Steel Institute, before which he had read a number of papers.

THE death occurred on the 24th ult., at his residence, Oakfield, Wolverhampton, of Mr. E. H. Stringer, J.P., at the age of 84 years. The deceased gentleman was for over fifty years the head of Messrs. Stringer Brothers, iron and steel manufacturers, Albion, West Bromwich

MR. H. TURNER, of Ash Lea, Brook Road, Moorsbrook, Sheffield, a partner in the firm of William Turner & Company, Clarence Works, Pond Street, died last month. An inventor of some repute, the most important of his many patents was that granted in the early nineties for his invention of the compound principle of compressing air. He was 59 years of age.

AFTER a short illness, the death has taken place suddenly of Mr. D. C. Crosthwaite, at his residence, 10, Lorne Terrace, Stockton. The deceased gentleman, who was the son of the late Alderman Crosthwaite, of Thornaby, was a director of the firm of R. W. Crosthwaite, Limited, ironfounders, Thornaby, with the life of which borough he took an active interest.

THE death of Mr. C. H. Inns, of Birmingham, occurred last month. Entering the employ of the Simplex Coke Oven and Engineering Company, Limited, Sheffield, just over twelve years ago, he showed foresight, tact, and business capabilities, which resulted in his appointment, six years ago, as secretary and manager of the company, and this position he occupied to the time of his illness.

MR. W. J. KEEP, one of the most prominent of American engineers, died on October 7 at the age of 76 years. For the past 35 years Mr. Keep has been affiliated with the Michigan Stove Company, Detroit, but he will probably be best known as the author of 'Keep's System of Mechanical Analysis." He was also the author of standard and practical technical works, including "Cast Iron," which he published in 1902.

THE death took place last month, at his residence, 36, Bairstow Street, Preston, of Mr. Thos. Dryden, J.P., proprietor of the engineering works bearing his name, at Grimshaw Street, Preston. The deceased, who was in his 70th year, was born at Higher Walton. He served his apprenticeship at Messrs. Whittaker's foundry, Higher Walton, of which his father, Mr. Wm. Dryden, was general manager, before starting in business on his own account.

WE greatly regret to hear of the death of Mr. Daniel Jones, of the Blue House, Donington, Albrighton. Mr. Jones, who was in his 83rd year, was a very well-known figure in the iron and steel trades of the Midlands. For more than a generation (until his retirement during the period of the war) Mr. Jones had been secretary of the South Staffordshire Ironmasters' Association, and one of the joint secretaries of the Midland Iron and Steel Wages Board, and it is impossible either to estimate or exaggerate the usefulness and importance of his work in this capacity.

THE death is announced at the age of 52 years of Mr. Alleyne Reynolds, who for many years was connected with the Sheffield works. He started business life in 1883 in the pattern shop of Messrs. Vickers, River Don Works, Sheffield, of which firm his father was one of the managing directors. He resigned his position in November, 1897, and was afterwards engaged in various kinds of special experimental work of a private nature, in several British and Continental works. Later he acted as special metallurgical consultant to the firm of Sanderson Bros. and Newbould, Limited, of Sheffield.

Personal.

THE late Mr. E. Whitwam, consulting engineer, of Huddersfield, left £28,003.

MR. C. L. BUDD, chairman of the London Metal Exchange, has resigned that position.

MR. J. T. BROWNLIE has been re-elected chairman of the Amalgamated Society of Engineers.

MR. ANDREW CARNEGIE celebrated his 83rd birthday, on November 27, at his home in New York.

THE late Mr. J. A. Hughes, brass founder, of The Chestnuts, Chester Road, Erdington, Birmingham, left £32,650.

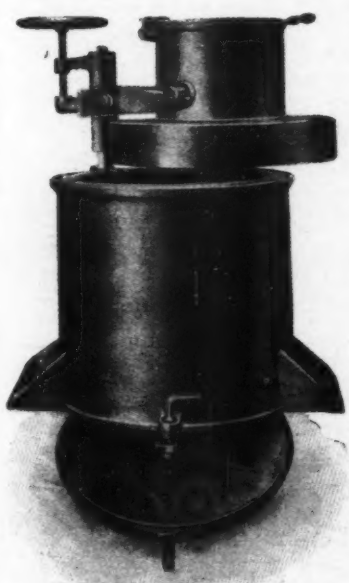
LIEUT.-COLONEL HARRY RHODES has been elected to a seat on the board of the Midland Iron Company, Limited.

MACNAB & Co.,

56/8, Eagle Street, Southampton Row, LONDON, W.C.1.

Reduce your fuel cost! Melt in a hurry!

For Brass, Gunmetal, Aluminium, Iron, etc.



Tylor Patent Pit-Type Furnace.

OUTPUT.

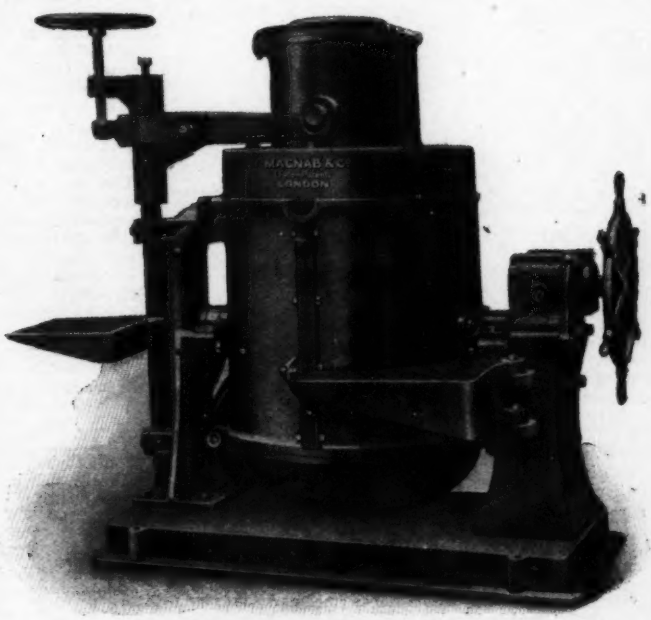
200 lbs Admiralty Gunmetal melted in 25 minutes. Temperature 2000° F.

ECONOMY.

20 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 35 to 40 heats.



Tilting-Type Furnace.

OUTPUT.

400 lbs. Admiralty Gunmetal melted in 45 minutes. Temperature 2000° F.

ECONOMY.

73 lbs. of Coke used per 400 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 35 to 40 heats.

The gross value of the estate of the late Mr. J. Boyd, engineer and ironfounder, late of Duncloths, Bothwell, is £54,965.

The late Mr. J. T. Oliver, of Whitley Bay, late assistant chief engineer of the North-Eastern Railway Company, left £4,801.

The late Mr. W. A. Savage, of the Zillah Engineering Company, left estate valued at £102,823 gross, with net personalty £96,021.

Mr. G. S. Glendinning has retired from the firm of John Glendinning & Sons, metal merchants, 90, West Campbell Street, Glasgow.

Sir James Marshall, K.C.B., has been appointed general manager of John Samuel White & Company, Limited, shipbuilders, of Cowes.

The late Sir George Benjamin Hingley, of N. Hingley & Sons, Limited, and the Harts Hill Iron Company, Limited, left property of the gross value of £329,169.

Mr. H. G. Griffiths, the manager of the foundry department of John Williams & Sons (Cardiff), Limited, has been elected a director of the company.

Mr. C. Leigh has been appointed general manager of Thermit, Limited. He was previously chief chemist to the Birmingham Metal and Munitions Company, Limited.

The late Mr. J. F. A. Pflaum, of Ashlar House, Potternewton, Leeds, formerly of the engineering firm of Tannett Walker & Company, Limited, Hunslet, left £31,394.

The gross value of the estate of the late Mr. J. R. Perrett, until two years ago chief naval constructor for Sir W. G. Armstrong, Whitworth & Company, Limited, is £22,401.

Mr. George Pate, general manager to the Carron Iron Company, has been the recipient of a presentation from the officials and men to mark the occasion of his semi-jubilee in the company's service.

Mr. R. F. Spanner has resigned from the Royal Corps of Naval Constructors, and has taken up an appointment as naval architect with R. H. Green and Silley Weir, Limited.

Mr. H. A. Buck, secretary of the London Metal Exchange, has received an appointment with the British Metal Corporation, Limited, and is leaving the Metal Exchange at the end of February.

Sir Vincent Raven has, owing to the armistice, resigned his appointment, under the Admiralty, of Controller of Armament Production, and has resumed his duties of chief mechanical engineer of the North-Eastern Railway.

Lance-Corp. George Onions, eldest son of Mr. Z. W. Onions, general manager of the Wolverhampton Steel & Iron Company, Limited, has been awarded the Victoria Cross. This, after the award of the D.C.M. earlier in the year to Mr. Onions' younger son, Archie, is very gratifying.

Major George Barnsley, who, since June, 1916, has been chief recruiting officer for Sheffield, is taking up an appointment as regional officer of civil national service at Leeds. Major Barnsley is a member of Messrs. George Barnsley & Sons, steel and file manufacturers, Cornish Works, Sheffield.

In commemoration of his 70th birthday, Mr. George Bradshaw, principal of the firm of George Bradshaw & Company, Limited, metal merchants, Cross Street, Manchester, has been presented with a silver loving cup by the members of his staff and those of J. F. Melling & Company, Limited, of Sheffield.

Mr. C. C. Paterson is terminating his appointment at the National Physical Laboratory, Teddington, and is joining the General Electric Company, Limited, as director of research laboratories, as from January 1. The offices of the Research Laboratories of the General Electric Company, Limited, will for the time being be at the Osram Robertson Lamp Works, Hammersmith, London.

The cordial relations existing between Mr. Douglas Vickers, M.P., chairman of Vickers, Limited, and the staff and employés at the River Don Works, Sheffield, were demonstrated last month, when the staff and employés handed over a sum of £1,200 which they had subscribed and which they wished to be devoted, as to the sum of £1,000, to the permanent endowment of a bed in the Royal Infirmary, to be known as the "Douglas Vickers Bed," and as to the balance of £200 to go to the Sheffield Royal Hospital on terms to be subsequently agreed upon. This movement by the employés was the outcome of a desire on their part to mark in some way their appreciation of the election of Mr. Douglas Vickers, M.P., to the chairmanship of the company, in succession to his father, Mr. Albert Vickers.

Legal.

"Snowballing" in Foundry Companies.

Elaborate frauds, involving no fewer than 21 companies and extending over a period of 21 years, were alleged in a prosecution initiated before Lord Ilkeston, the Birmingham Stipendiary, last month at the Victoria Courts. Most of the frauds were said to have related to transactions in scrap metal and fuel. The defendants were Herbert Charles Harvey and his two sons, Herbert Harvey and Ernest Kent Harvey, described as iron, brass, and general founders. The information was laid by George Henry Grant, partner in the firm of Messrs. Grant Brothers, Letherville, Ventnor, Isle of Wight.

Mr. Gocher, prosecuting, said he applied for a remand of the whole of the defendants, who were charged that between the months of May, 1912, and November, 1918, in the city of Birmingham, they unlawfully conspired and combined by divers false pretences and subtle devices to defraud various persons of their goods. The method of conspiracy adopted by the three defendants was alleged to have been in operation for a period of twenty years. Commencing with the registration of a company on July 12, 1897, no fewer than 21 companies had been formed as follows:—Star Foundry Company, Limited, registered July 12, 1897; Aston Cross Foundry Company, Limited, registered November 6, 1903; Harvey & Friend, Limited, registered April, 1905; Harvey, Stevens & Company, Limited, ditto; H. G. Harvey & Sons, Limited, ditto; Harvey, Son & Co., Limited, registered August 8, 1906; Harvey & Wood, Limited, registered March 28, 1908; Harvey & Whitehouse, Limited, registered October 28, 1908; Aston Cross Foundry & Iron Plate Works Company, Limited, registered 1909; H. C. Harvey & Company, Limited, registered December 29, 1909; Harvey & Stevens, Limited, registered August 20, 1910; Harvey & Company (Birmingham), Limited, registered January 25, 1911; the Aston Cross Foundry, Limited, registered August 1, 1911; Harvey & Company (Aston Manor), Limited, registered October 4, 1911; H. C. Harvey, Limited, registered June 6, 1912; Harvey, Hiley & Company, Limited, registered; Harvey & Bishop, Limited; Harvey & Morriss, Limited; Harvey & White, Limited; the Templeboro' Manufacturing Company, Limited; the Madagascar Contract Syndicate, Limited.

The procedure adopted was to form a company and trade for a short time, and then buy goods on credit not as a rule from Birmingham people, but from firms scattered throughout the country as far distant as the Isle of Wight in one direction to South Wales and Scotland in the other, including Suffolk, Shropshire, and other counties. When creditors began to press for the payment of their goods, as soon as a writ was issued and possibly judgment obtained, the Harvey family, taking advantage of perpetual debentures which they had created on the assets, would seize the assets on that particular warrant as debenture-holders and sell those assets to a new company which had been formed to carry on the same kind of trade. They succeeded in obtaining scrap iron, fuel, and similar material on

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TRADE SIROCCO MARK

FANS

SEND US YOUR ENQUIRIES FOR

are always successful in the struggle for the Mastery of the Air

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ARE YOU MAKING MANGANESE BRONZE CASTINGS?

IF SO you are possibly one of many Manganese Bronze Founders still adding your Manganese by means of Ferro-Manganese. There is a better way—a more scientific way. These notes should help you to find it.

THE FERRO-MANGANESE or RISKY WAY.

Ferro-Manganese will only melt at a temperature considerably above the melting point of Cast Iron, and in order to alloy same in the manufacture of Manganese Bronze a very high furnace temperature is necessary. Thus it invariably happens that the metal is considerably overheated, with the result that great harm is done to the Manganese Bronze and little, if any, benefit is derived from the addition of the Manganese.
Moreover, Ferro-Manganese contains large amounts of objectionable impurities which cannot be removed during its manufacture, and are therefore carried into the Manganese Bronze.

THE MANGANESE COPPER or SCIENTIFIC WAY.

IS TO USE MANGANESE COPPER instead of Ferro-Manganese, owing to the many advantages it possesses which make for uniformly good results in Manganese Bronze manufacture. MANGANESE COPPER melts at a lower temperature than Copper, and overheating during alloying is impossible. Furthermore, in the preparation of "Stella" Brand Manganese Copper all impurities are removed and absolute uniformity and purity is guaranteed.

In modern scientifically controlled methods it is essential that Manganese be introduced into Manganese Bronze in definite percentages—free from objectionable impurities and in such a form that it can be conveniently and economically added to the required mixture.

Stella Brand Manganese Copper DOES THIS.

USE ONLY Stella Brand MANGANESE COPPER.

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UNITED BRASS FOUNDERS & ENGINEERS, LD. MANCHESTER.

EMPRESS FOUNDRY, CORNBROOK.

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credit, and that kind of thing had gone on all those years. For 21 years the system had been in operation of "snowballing" and passing on goods from one company to another. It was impossible to say at the present stage whether there would be further charges, but there would have to be investigations, and he applied for a remand for eight days to enable the evidence to be collected. Creditors would be brought to the court from all parts of the country, and they hoped that others would appear in the interests of justice.

After evidence of arrest had been given the defendants were admitted to bail, themselves in £100 and each of them with two other sureties of £50 each. They were remanded, and on again appearing before the Birmingham Stipendiary, a further application was made for a remand. On this occasion Mr. Willison appeared for the defence. The defendants, Herbert Charles Harvey and his two sons, Herbert Harvey and Ernest Kent Harvey, described as iron, brass, and general founders, again entered the dock. Mr. Leonard Gocher (for the prosecution) asked for three weeks' remand.

Mr. Willison, who appeared for the defence, said he had no objection to offer to this. He was only anxious that a sufficiently long period should be allowed for the whole of the investigations to be completed so that he (Mr. Willison), might be furnished with the particulars to enable him to prepare the defence. Mr. Gocher said he had now discovered seven additional companies which had been registered in connection with this matter, making a total of 28. The defendants had kept no proper books or accounts, but there were a great quantity of papers to go through. He was receiving communications by letter and by telephone from people in various parts of the country, and the case was attaining such dimensions that an adjournment of less than three weeks would be useless.

Eventually an adjournment until January 14 was granted, bail being allowed as before. The following are the additional companies referred to by Mr. Gocher, with the dates of their registration:—Star Foundry (Tipton), Limited, May 30, 1899; Limerick Foundry, Limited, February 13, 1902; H. C. and F. Harvey, Limited, April 3, 1903; Williams & Company, Limited, October 19, 1904; Harvey & Brookes, Limited, April 30, 1914; Harvey & Mutlow, Limited, April 25, 1918; Evans & Yeomans, Limited, October 30, 1918.

High-Speed Steel Patents.

An appeal was before the Law Lords in the House of Lords on December 6 in which Darwin & Milner, Limited, and Stahlwerk Becker Aktiegesellschaft were the appellants and Arthur Balfour & Company, Limited, of Sheffield, were the respondents. The latter applied to the courts for a revocation of letters patent granted to the last-named appellants in respect of an alleged invention of an improved high-speed tool steel.

Mr. Justice Younger held that the letters patent were invalid, and that the respondents were entitled to an order that they be revoked. The Court of Appeal unanimously upheld this view. The appellants now maintain that these decisions were erroneous, because there was no prior publication of the invention, and that the facts proved amounted to no more than a secret and experimental prior user. As against this, the respondents contend that the letters patent are, and always have been, invalid by reason of a prior publication within the Realm, prior public user within the Realm, and absence of proper subject matter.

The Lord Chancellor, in moving that the appeal should be dismissed, said it would be very dangerous to introduce the doctrine that it must be actually shown that knowledge had been acquired by some individual. The law as to prior user seemed to be that, if an article had been manufactured or sold, that gave the means of knowledge to the purchaser. That was enough to establish prior user.

Lords Atkinson, Shaw, Sumner, and Wrenbury concurred.

Non-Ferrous Metals Suspension Order.

The Minister of Munitions has suspended until further notice the following orders:—

The Copper (Sale or Purchase) Order, 1916, which prohibited dealings except by special permit.

The Copper (Use in Manufacture) Order, 1916, which prohibited use in manufacture except for orders within class A or B priority.

The Copper (Control) Order, 1917, which took possession, with certain exceptions, of all unwrought copper, including copper scrap and swarf, and also required returns.

The Brass and Copper (Returns) Order, 1916, which required returns of output of brass or copper rod, tubing, sheets, etc.

The Brass (Swarf and Scrap) Control Order, 1917, which took possession of—

(a) All yellow brass and cartridge metal swarf turnings and borings,

(b) All yellow brass scrap resulting from the manufacture of war material,

and also required returns.

The Cupro-Nickel Scrap (Dealings) Order, 1917, which prohibited dealings except under licence.

The Spelter (Control) Order, 1917, and the Spelter Control (Amendment) Order, 1918, which prohibited dealing, etc., or use in manufacture except by licence and required returns of stocks, etc.

The Lead Order, 1917, and the two Lead Control Amendment Orders, 1918, which took possession, with certain exceptions, of all pig lead, scrap lead and lead residues; prohibited purchase or sale, etc., or use in manufacture except by licence; required returns, and fixed maximum prices for such lead, manufactured lead, lead compounds, and used type metal.

The Type Metal (Returns) Order, 1918, which required returns of stocks from persons having more than 1 cwt.

The Tin (Dealings) Order, 1917, and the Tin (Dealings) Order, 1918, which specified tin as war material and prohibited dealings, etc., or use in manufacture except by permit and required returns.

The Aluminium Order, 1916, the Aluminium (Returns) Order, 1917, and the Aluminium (Scrap and Swarf) Order, 1917, have been suspended, and revoked the Refractory Materials (Maximum Prices) Order, 1918.

Stocks.

In order that the trade may know the position in regard to stocks of the important metals, the following particulars are published of the stocks (exclusive of old metal and scrap) in this country in the possession of the Minister of Munitions on December 1, 1918, viz.:—

	Tons.
Copper	27,530
Spelter G.O.B.	18,768
,, Refined	6,544
Aluminium	10,215
Soft pig lead	49,111
Nickel	1,735
Antimony regulus	3,303

It is intended to publish, at monthly intervals, the stocks held on the first day of each month. In addition to the above the Minister holds large quantities of scrap, mainly brass, of which it is impossible to give any figures at present.

Restrictions on Non-Ferrous Metals.

The Ministry of Munitions, in the disposal and allocation of stocks of non-ferrous metals in their possession to consumers, will be prepared to pay brokers and recognised intermediaries a commission of ½ per cent., subject to cash payment for the material.

MOTOR CYLINDERS!

If you wish to be successful in the manufacture of the above it is essential that you use

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For particulars apply to the Makers:—

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HALIFAX.

Telegrams:—"SPERMOLIN, HALIFAX."
Telephone: 397 HALIFAX.

New Companies.

Leach, Stuart & Company, Limited.—Capital £3,000 in £1 shares, to carry on the business of engineers, etc. Registered office :—32, Queen Victoria Street, E.C.

C. Portass & Son, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers' manufacturers. Registered office: 70-72, Broadfield Road, Sheffield.

B. Hague & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of hosiery machine builders. Registered office :—Poplar Street, Nottingham.

Nutlok (British Patents), Limited.—Capital £10,000 in 2s. shares, to enter into an agreement with Nutlok, Limited. The first directors are H. Krall and P. E. Butler.

V.R. Pump, Limited.—Capital £500 in 470 "A" shares of £1 each and 600 "B" shares of 1s. each, to acquire the British and U.S.A. rights of W. J. Vincent in a patent rotary pump.

General Engineering Company (Hornsey), Limited.—Capital £12,000 in £1 shares, to acquire the business carried on at Campsbourne Works, High Street, Hornsey, by Marks, Tonge & Kamenicek.

Cleaver, Limited.—Capital £12,000 in £1 shares, to acquire the business of manufacturers of jigs, tools and gauges carried on at the Reliance Works, 115-116, Hope Street, Birmingham, as A. Cleaver & Co.

Watts, Fincham & Company, Limited. — Capital £60,000 in 5,000 preference shares of £10 and 10,000 ordinary of £1, to carry on the business of engineers' merchants. Registered office: Billiter Buildings, E.C.

Lithgows, Limited.—Capital £2,000,000 in 20,000 shares of £100 each, to acquire the business of Russell & Co., shipbuilders and ship repairers, Port Glasgow. Registered office: Kingston Shipbuilding Yard, Port Glasgow.

Allcocks, Limited.—Capital £2,000 in £1 shares, to acquire the existing business of brassfounders. The first directors are W. L. Douglas-Osborn, E. H. Douglas-Osborn, J. Smith, and C. J. Douglas-Osborn. Registered office :—24, King Edward's Road, Birmingham.

Lewis Engines, Limited.—Capital £20,000 in £1 shares. First directors: A. D. Axarlis, T. E. Lewis, F. Lewis, and P. Ashcroft. A. D. Axarlis (a British subject of Greek origin) is chairman. Registered office: Imperial Buildings, Mount Stuart Square, Cardiff.

G. M. Emanuel & Company, Limited.—Capital £76,000 in £1 shares, to carry on the business of copper, iron, steel, and brass manufacturers, etc. The first directors are S. Emanuel, F. Emanuel, and G. Emanuel. Registered office: Westwood Works, Witton, Birmingham.

Published at the Instruction of the Ministry of Munitions of War by the Imperial College of Science and Technology and the University of Liverpool.

A Memoir on BRITISH RESOURCES of

REFRACTORY SANDS

FOR FURNACE & FOUNDRY PURPOSES.

PART I.

By P. G. H. BOSWELL, O.B.E., D.Sc.,

Professor of Geology in the University of Liverpool, Scientific Adviser (Geological) to the Department of Iron and Steel Production, Ministry of Munitions of War.

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For all Soft Metals, Aluminium Alloys, &c.

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MONOMETER DIE CASTING MACHINE,
WHITE METAL MELTING FURNACE,
MOULD AND BEARING HEATING OVEN,
and TINNING FURNACE.

We are also Makers of Crucible and Non-Crucible Furnaces in capacities from 30 to 1,000 lbs., and from 1,000 lbs. to 10,000 lbs., for all Ferrous and Non-Ferrous Metals, Steel, Malleable Iron, &c.

THESE PLANTS ARE BEING EXHIBITED DURING DEC. 27 TO JAN. 9 AT THE EXHIBITION OF BRITISH SCIENCE PRODUCTS, MANCHESTER.

Sole Makers:—THE MONOMETER MANUFACTURING CO., Ltd., ASTON, BIRMINGHAM.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

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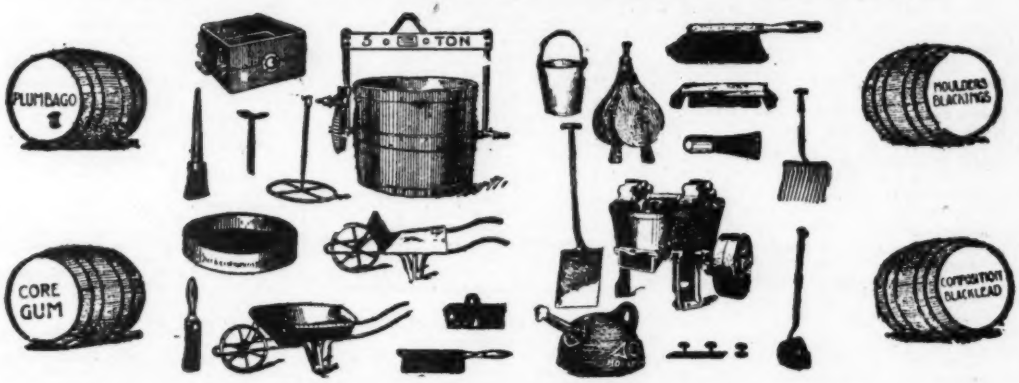


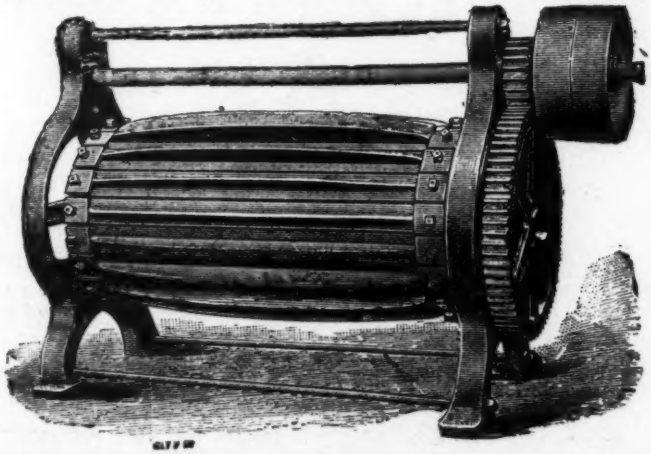
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos. 1, 2 and 3	6	7	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S. ..	6	7	6
Special under 0.03 P & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3..	6	2	6
Special under 0.03 P. & S. ..	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
HEMATITE—MALLEABLE— Refined—			
Refined Cupola Cast	8	0	0
Refined Cupola Cast to guaranteed analysis..	8	5	0
Cast direct from Blast Furnaces—			
Small Pig-Iron, all grades ..	7	10	0
Medium Pig-Iron White to Grey mottled	7	5	0
Medium Pig-Iron, all other qualities	6	17	6
Large Pig-Iron, all grades ..	6	17	6
Lincolnshire, basic or foundry ..	4	17	6
Cleveland, No. 1	4	19	0
„ other grades	4	15	0
„ basic	5	0	0
Northamptonshire, forge	4	7	6
„ fdy numbers	89/0		94/0
„ basic	4	17	6
Derbyshire, forge	4	10	0
„ foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge ..	4	10	0
„ „ foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
„ „ foundry	4	17	6
„ „ basic	4	17	6
South Staffordshire—			
Part mine forge	5	0	0
„ foundry	5	2	6
Common Staffordshire	4	15	0
All mine forge	5	15	0
„ foundry	6	0	0
Warm air forge	7	5	0
„ foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Basic	4	17	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works.

Mers. Com. 1½%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 3s. 8d.

Finished bars, 18% Tung. 4s. 5d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings	8d.
Bar Ends	9d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton		—	
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton		—	
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton		—	
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton		—	
Ferro-vanadium: 35/40% Va., per lb. of Va. contained in the alloy		—	
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton		—	
Ferro-titanium: 23/25%, per lb. carbonless..		—	
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained ..		—	
Ferro-phosphorus: 20/25%. Per ton		—	
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained		—	
*Ferro-manganese 80%	28	10	0
„ export		—	

* F.o.b. Liverpool.

Non-Ferrous Metals.

	£	s.	d.	£	s.	d.
Copper.						
Standard, Cash ..	95	0	0	96	0	0
Three months ..	86	0	0	88	0	0
Electrolytic	105	0	0	103	0	0
Tough	103	0	0	—		
Best selected	103	0	0	—		
Tin.						
Standard, Cash ..	256	0	0	256	10	0
„ Three months	247	10	0	248	0	0
English Ingots ..	256	0	0	—		
Bars	257	0	0	—		
Refined	—			—		
Spelter.						
Ordinary	57	0	0	—		
Specials.. ..	—			—		
Hard	40	0	0	41	0	0
British	—			—		
Lead.						
Soft Foreign (net) ..	40	0	0	—		
English	—			Nom.		
Antimony.						
Regulus	—			55	0	0
Aluminium.						
Virgin Metal 98/99% per ton	—			—		

Phosphor Bronze.

Ingots.	Per ton
Alloy No. I. or II.	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots.. ..	—

Castings.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid ..	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. £50 above price of best selected copper.

15 per cent. Phosphor Copper .. £70 above price B.S.

Phosphor Tin (5 per cent.) .. £30 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM).

*Chromium (Metallic). 98/99% purity, per lb.	—
*Nickel. In cubes, 98/99% purity Per ton	—
Nickel Silver.	per lb.
Ingots for raising	—
Ingots for Spoons and Forks ..	—
„ rolled to spoon size ..	—
*Tungsten Metal Powder. 98/99% purity.. per lb. ..	—
*Molybdenum Metal. 98/99% purity.. per lb. ..	—
*Cobalt Metal. 97% purity .. per lb. ..	—
Quicksilver. 75 lb. bottle	—

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	£	s.	d.	£	s.	d.
Steel scrap, heavy melting..	—			—		
Iron scrap cast (cupola metal)	—			—		
London (f.o.b.).						
Heavy steel				104	6	
Light „				55	0	
Heavy cast				110	0	
Control Prices.						
Heavy Steel Melting Scrap	105	0		125	0	
Steel Pianings, Turnings and Borings				65	0	
Steel Pianings, Turnings and Borings mixed with Wrought Iron, &c.				50	0	
Steel Scrap, all other Classes ..				95	0	
Wrought Iron Scrap				125	0	
Ditto, mixed with Steel				95	0	
W.I. Pianings, Turnings and Borings mixed with Steel, &c.				50	0	

Per ton delivered Buyers' Works.

Cast-Iron Scrap.

	£	s.	d.
Hy. ord. brkn., between 1½ cwt. and 10 cwt.	4	15	0
Hy. machy., brkn., bet. 1½ cwt. and 10 cwt.	5	0	0
Cold blast, brkn., bet. 1½ cwt. and 10 cwt.	6	15	0
Ingot mould, unbroken	6	0	0
Ditto, brkn., bet. 5 cwt. and 2 tons	6	5	0
Ditto, between 1½ cwt. and 5 cwt.	6	10	0
Extra for breaking into pieces not exceeding 1½ cwt.	0	5	0
Railway chairs for re-melting ..	5	0	0
Heavy lumps, not above 2 tons ..	4	12	6
Light	4	5	0
Burnt, broken, ready for cupola ..	3	0	0
Burnt fire bars	4	0	0
Turnings and borings for iron and steel makers	3	5	0

Per ton f.o.r. or f.i.b. Scrap merchants' commission, 2½ per cent.; additional 10s. allowed, except for railway chairs and turnings and borings, to cover inwards carriage and handlings on sales from scrap yards.

Coke.

Middlesbrough.	s.	d.	s.	d.
Gas Coke	—		55	0
Foundry	65	0	70	0
Glasgow.				
Foundry Coke	—		47	
Furnace Coke	37	0	—	
London.				
Welsh or Durham Foundry, d/d London Stations in truck	45	0	53	
Ditto, d/d Birmingham Statns.	44	0	46	
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Durham & Northumbd. blast furnace	33	0
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Yorkshire, Lancashire, Staffordshire, Notts., Derbyshire, Lincs., & Midland Counties blast furnace	32	0
Ditto. foundry..	45	0
Ditto. steel melting (Sheffield Dist.)..	54	0
South Wales blast furnace ..	37	6
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All per ton net. f.o.t. ovens.		
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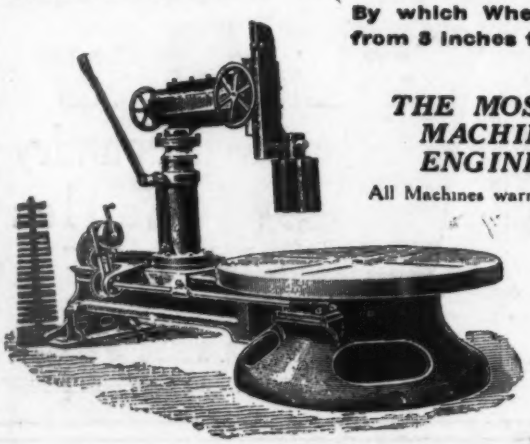

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